

CHEMICAL & METALLURGICAL ENGINEERING

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James H. McGraw, *President*
E. J. Mehren, *Vice-President*

H. C. Parmelee
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What is Chemical Engineering?

THAT there is no abatement of interest in chemical engineering education was evidenced by the recent conference at Columbia University under the auspices of the American Institute of Chemical Engineers. Representatives of thirty institutions teaching that branch of engineering spent a day discussing policies and debating moot points. That the conference was helpful is certain. That it closed with one difference of opinion as acute as it was friendly is equally true.

THE point of departure for two diverse views centered in the conception of chemical engineering. Is it plain chemistry, or so-called industrial chemistry, a mere flirtation of the chemist with the intriguing title of engineer? Or is it really a branch of engineering with clearly defined functions in the realm of industry? Is chemistry engineering, or is it science? Is a chemist a chemical engineer? Or are these individuals different products of different courses of training, with different functions and fields of usefulness? It is in the answers to these questions that there must be a meeting of minds before chemical engineering as generally interpreted will find acceptance with the minority.

EVIDENTLY there is need of definition, which can be derived from a few practical considerations. Chemical engineering connotes industrial production, the application of fundamental science in industry. It is a structure raised on chemistry, physics and mathematics, which underlie it. A similar parallel appears between electrical

engineering and physics. In the science are found the fundamental principles; in the corresponding branch of engineering, their industrial application.

GIVEN a problem in industrial production, the chemistry involved may be comparatively simple, comprehensible to a freshman student. A salt solution electrolyzed yields chlorine and caustic soda. Limestone burned in a kiln evolves carbon dioxide and becomes calcium oxide. Sucrose can be and profit in the quantity production of obtained from beets, and bromine can be recovered from sea water. But efficiency and profit in the quantity production of these things call for engineering skill in applying forces, designing equipment and selecting materials of construction, so that the products may become articles of commerce. Chemistry? Yes. Engineering? Certainly.

CHEMICAL engineering is evolving. In the slow process of gaining acceptance as a distinct branch of engineering, the definition of its outlines by the American Institute of Chemical Engineers has been of the greatest value. The general pattern is clearly delineated and stands as a guide for the education of men adaptable to the widest industrial usefulness. The scientific foundations are chemistry, physics and mathematics. The engineering aids are certain operations and equipment that give the sciences their industrial utility. Chemical engineering recognizes and accepts chemistry as its corner stone, but it is more than chemistry. The two are complementary, but neither synonymous nor identical.

Fine vs. Coarse Carbon As a Decolorizing Medium

PRACTICE in sugar-liquor decolorizing is undergoing a slow but certain change. A sporadic discussion on the relative value and applicability of coarse and fine char, respectively, has been appearing of late in the columns of our contemporary *Chemistry & Industry*. We have followed this with considerable interest, objecting, however, to the classification inferred by some of the writers, which places coarse bone char outside the class of activated carbons, although we are willing to admit that "activation" is a term of relative significance. One writer maintained with logic that the use of a finely-ground, highly-activated char means a lower investment in decolorizing medium, as compared with the cost of coarse bone char; and that by its use there is a saving in plant space and a saving of steam necessary to concentrate "sweet water," the amount of which is reduced in proportion to the reduction in adsorbent effected by the change. Other advantages are obvious to those who have followed the trend of technical developments in recent years.

What was perhaps the most unexpected reply to these recommendations came from a research scientist, who maintained that, because few refiners had adopted finely ground and highly activated char in place of coarse and feebly active char, the advantages are not sufficiently great to justify the discarding of the clumsy filters now favored by the more conservative element, in spite of the recognized irregularity of percolation by normal procedure. This attitude toward an innovation or an invention is merely a repetition of history. It is rare that a simple and logical change in method is accepted on its merits. So many prefer to "sit on the fence," watch the experiences of others and damn the improvement with a graduated amount of faint praise until the eve of its general adoption.

The use of a finely ground adsorbent for the decolorizing of sugar liquor is ultimately inevitable, despite the unwillingness of some to consider the change. Sugar refiners may be acting unwisely in continuing the use of a costly, slow and inefficient process because of past plant expenditures for clumsy apparatus. The alternative to this policy of excessive caution will probably be a radical change that will not be welcome in some quarters—the refining of the sugar at the plantation and the effecting of significant economies in cost. A reviewer in the London contemporary to which we have already referred states that "During the 'crop' just commenced, the Mercedita factory at Porto Rico, which hitherto has produced 96 deg. raw sugar for the refineries, will itself refine raw sugar, using a carbon plant having a capacity of about 250 tons per day, and will produce plantation refined granulated for the American market of a quality not inferior to that made by any home refinery. Further, arrangements are being made to establish similar plants in other cane-growing countries. . . ."

When crude sugar is in "melted" form, its complete filtration and decolorization is surely a logical step, especially if the two operations can be combined. One contributor to the discussion mentioned maintains that a good decolorizing carbon should also be a good filter aid. This it doubtless is; but we question if the expense of the additional carbon needed would be justified. Specially prepared diatomite has proven economical and efficient for this purpose; and among patents issued during 1925 we noted one that provides for the use of

a mixture of decolorizing carbon and diatomite, whereby a considerable saving in time of processing is claimed.

It is doubtful if any phase of technology offers greater promise for the innovation of economies than does the decolorizing of sugar liquor. The potentialities of surface action have only been realized in recent years, and experience is proving that preliminary subdivision to a maximum is a necessary preliminary to efficient, prompt and economical adsorption effects. Finely ground and highly activated char seems certain to displace eventually the coarse decolorizer used in so many refineries.

Conditions in Germany

A GERMAN engineer visiting in this country reports that industrial conditions are none too favorable in his native land. The direct evidence of industrial depression is found in unemployment, which has increased to a point comparable to that in England. The cause, in his opinion, is largely the inability of German manufacturers to market their surplus production abroad, due to the tariff barriers erected by other countries. In this respect the United States is regarded as one of the chief offenders, considering the large potential market this country offers for many German products. This raises one of those difficult problems in international affairs—the maintenance of a proper degree of self-protection, at the same time affording debtor nations a reasonable opportunity to work out their salvation. The latter is usually accomplished through the exploitation of some form of natural monopoly which most nations possess. Germany is not without such resources and will undoubtedly make the most of them. In addition, she has reorganized her chemical and other industries under the most able leadership. Thus far the conditions of the Dawes' plan have been successfully met. Whether the present depression will assume proportions warranting a modification of the terms of the plan can only be determined when the next report is made.

The House Votes for Limitless Energy

ON April 5 the House of Representatives added to the gaiety of technical circles by officially recognizing the "limitless energy" scheme of Garabed T. K. Giragossian. Garabed is becoming the hardy perennial of the Capitol. It was in 1918 when the country was desperately in need of power that the first induced Congress to listen to his proposal. Again in 1922 he bobbed up with the idea of "aiding agriculture by providing facilities for nitrate plants, water for irrigation, and for promoting more efficiency in travel and transportation through the elimination of expense or labor for motive power." Now the House bill recognizes him as the "first and original inventor" of an unrevealed method of producing unlimited energy. The whole proceeding smacks of buying a pig in a poke, and reminds one of the harmless boyhood pastime of trading "sight unseen."

Garabed prevailed upon credulous Congressmen to listen to his fanciful tale, alleging that he feared theft of his idea if he disclosed it to the Patent Office. This is a novel method of protecting an invention, the mere suggestion of which should have been enough to put Congress on its guard. With governmental machinery

set up for patenting inventions there is no excuse for giving special consideration to an alleged invention that bears all the ear-marks of fraud or folly.

Only 70 of the 435 members of the House were in attendance when the vote was taken. Thirty-eight of these were duly impressed, while 32 opposed the bill. To the objection that Congress knew nothing about the process and consequently could not declare whether or not Garabed is the first and original inventor, the naïve reply was made that "if it is a fake the Government is not damaged, if it is a benefaction to the human race, we shall be proud of it." In short, no matter how foolish or fantastic an idea may be, it ought not be frowned upon by Congress if it can do no harm and might do some good.

Improving the Quality of Welded Joints

WELDING as a means of fabricating new equipment for the chemical engineering industries, and also as a method of making repairs, has assumed a position of much importance during the past few years. Because joints made in this way can be depended upon not to leak and also have other important advantages, it is not now unusual to find plants in which all the equipment and all the pipe joints are welded. And the welding arc or torch has become the principal tool of the repair gang.

Under these conditions it is only natural that an improvement in welding methods should be a matter of great interest to the whole field of chemical engineering. For this reason the two new methods recently developed by the General Electric Co. for improving the ductility and strength of welded joints deserve attention.

One of these methods, described elsewhere in this issue, consists of welding with carbon or metallic electrodes in an atmosphere of hydrogen, methanol, water gas, dissociated ammonia, or any other gas by means of which a supply of molecular hydrogen gas can be obtained. The other method, to be described in the next issue of *Chem. & Met.* consists of welding by means of atomic hydrogen.

Both of these welding methods prevent the formation of oxides and nitrates in the welded joint. As a consequence the joint is as ductile as, or more so than, the metal on either side and it develops the full strength of the metal from which it is made. When these methods become commercially available, it seems certain that the already highly useful process of welding will attain an even wider use in the chemical engineering industries.

Qualifications and Rewards of Teachers

RECENT studies by W. E. Wickenden, director of investigation of the Society for the Promotion of Engineering Education show that during the first 20 years from graduation the median academic salaries of engineering teachers approximates that of the lowest tenth of the graduates; but "as between the upper quarter of the graduates and the upper quarter of the teachers only long distance methods of financial communication are possible." The study, which was based on returns from 6,000 graduates and 2,000 teachers of engineering representing 75 institutions, is a startling revelation of the inadequacy of pay in a branch of education that, bar none, is vital to the furtherance of civilization.

A possible remedy lies in a plan that already has succeeded markedly in at least one institution. The faculty members—those of professional rank—are restricted sharply in numbers. They are seasoned engineers, recognized in their profession, and are paid good salaries. Being of higher caliber, they can build up a consulting practice of goodly proportions. But much of the instructional work beyond the freshman year is done by relatively younger men who are admittedly a transient body and who are therefore more interested in development through practice in original research under inspiring leadership, than in present monetary rewards. Such a plan presumes suitable facilities for research, and a larger staff than would be required for teaching duties alone; but schools of engineering worthy of the name should have equipment, and furthermore, they should do and publish investigative work.

We hope that college presidents and boards of trustees will not follow too literally the economic law of supply and demand. Mediocrity will always be attracted to teaching, however low the salary, because as compared with active life, mediocrity suffers no discount in that calling. But to attract and hold the qualified man—the man of personality, vision, mental alertness and technical ability—adequate salaries and respectable future rewards must be offered.

A Notable Achievement In Gas Manufacture

PROGRESS in the manufacture of carbureted water gas has not been evident until recent years. In fact, until ten years ago, this process was, except for refinements in the equipment, about in the same state as when first devised. In the United States at least, because of the abundance and reasonable cost of hard generator fuel and gas oil, the process was far more largely used than any other for supplying gas and it was, on the whole, satisfactory in operation.

With the war and the ensuing era of high prices, however, the whole situation underwent a change. Hard fuel became relatively scarce and costly while gas oil, due to the other great demands for petroleum products, rose to almost prohibitive price levels. The natural reaction to this situation was an immediate and almost feverish search for a method of manufacturing water gas economically from bituminous coal and a parallel attempt to cut down the quantity of gas oil used for enrichment.

One of the successful efforts in this field is described elsewhere in this issue, in the article on "Developing a Water Gas Process Using Bituminous Coal," by H. K. Seeley. This tells of the experiments conducted by W. J. Murdock, superintendent of the Joliet, Illinois, plant of the Coal Products Mfg. Co., whose efforts have resulted in the design of a new type of generator. This generator can be run entirely on bituminous coal as the raw material and such operation results in a saving of about one-third in the cost of generator fuel.

Such an achievement is indeed heartening. It serves to prove once more that when necessity arises, American engineers can be depended upon. While much remains that must be done if the gas industry is to fill its proper place in industrial and domestic service, this new "Pier" process marks a long step forward and renews again our hope that gas will some day be able to occupy the position as a fuel to which its qualities entitle it and which only its comparatively high cost has so far prevented it from attaining.

Cost Analysis in Chemical Production

Comparative graphs yield significant information on large-scale nitric acid, oleum and explosives manufacture

By Chaplin Tyler

Assistant Editor, Chem. & Met.

ORDINARILY the compilation and publication of extensive comparative manufacturing costs by any industry in the chemical engineering group is not to be expected. Competitive conditions preclude such a policy, and even granted that an industry could agree on the liberal exchange of accurate cost data, the ultimate benefits to be gained thereby are extremely doubtful. True, the adoption by many trade associations of uniform cost systems has marked a great forward step, but the good effects have come from a wider dissemination of accounting principles with the abolition of unintentional price cutting, and not from an intimate knowledge of the other fellow's costs.

Within a given organization, however, as for example among departments and subsidiary plants, comparative costs are invaluable as a guide to intelligent administration. Not only can a spirit of good-natured rivalry be fostered among superintendents and foremen, but the setting up of suitable budget standards is facilitated and unexpected economies in factory practice will be effected. The War provided an exceptionally favorable setting for large-scale cost comparisons of this sort, and with characteristic thoroughness, the British Government, through the Factories Branch, Department of Explosive Supply, applied unified production control with marked success to chemical manufacturing in more than 20 plants. Cost reports were sent to a central statistical office from all factories in the group. These costs were analyzed and comparative statements prepared, care being taken to put all factories on a uniform basis as far as possible.

The numerical and graphic statistics of this discussion are based on actual production data as recorded in reports of the Factories Branch. As the greater part of the original report gives costs for the early part of 1918, all raw material charges have been corrected to a 1926 basis, and in this form it is believed that the figures will approximate present ratios of material cost to operating cost.

Necessarily a uniform system of operating reports, plant accounts, and costs had to be formulated preliminary to the preparation of comparative statements, and the essentials of this system are outlined herewith.

Capital Expense.—No allowances have been made for interest on investment, taxes, insurance, depreciation, or other items of capital expense, as these were subject to extremely wide variations, and no useful purpose would be served by including them in a total together with the relatively accurate costs of operation. Those interested in the relative magnitude of capital expense, can determine this approximately by a consideration of the nature of the process, cost of raw materials used, and type of equipment. For example, one extreme would be the manufacture of sulphuric acid by the contact process, in which the raw materials are cheap, operation continuous, and investment in equipment large. Based on the total cost, capital expense in this

process has been found to range from 15 to 25 per cent, with 20 per cent as an average figure for good working. But for the fact that operation is continuous, the proportion of capital expense would be much greater. In contrast, consider now the manufacture of nitric acid by the ordinary batch process from sodium nitrate. Here the raw materials, especially the nitrate, are relatively expensive, but the equipment is simple and correspondingly cheap. As a result, capital charges form only 3 to 5 per cent of the total cost of manufacture.

Plant Accounts.—Raw materials were determined accurately, all quantities shown on the factory cost sheet being checked against the corresponding technical records. To simplify stock-taking and statistical calculations, factory months consisted of either 4 or 5 even weeks, there being two 4-week and one 5-week periods to the quarter, consequently there was no conflict between the weekly and monthly inventories. The ton of 2,240 lb. was used for all quantities of materials.

Cost of Raw Materials.—Raw materials were charged at a uniform cost delivered to all factories and on the basis of 100 per cent strength. Prices for materials have been corrected to a 1926 basis, delivered to factories in the East. Prices for intermediate products such as nitric acid, and sulphuric acid, correspond to the cost of manufacture as given in the tables.

Allowance for Byproducts.—Allowance has not been made for special charges and credits dependent upon local conditions, although these are factors affecting comparative costs. For example, credit may accrue from sale of salt-cake, niter-cake, pyrites cinder or waste acid.

Maintenance and General Expense.—The scope of maintenance charges and general expense was defined clearly in order to insure absolute uniformity in the returns from various factories. Maintenance as defined includes direct labor and supplies charged to plant upkeep, plus a fair proportion of maintenance burden, which comprises indirect charges such as salaries of maintenance foremen, draftsmen and engineers, and the upkeep of repair and maintenance shops. Shop burden is distributed on the basis of labor-hours required by each department.

General Expense.—General expense comprises items that cannot be allocated directly to a given factory or department of a factory. It includes:

1. Administrative salaries.
2. Office salaries and expense.
3. Research, development and control laboratories.
4. Stores-keeping.
5. Internal transportation of men and materials.
6. Watchmen and fire protection.
7. Sanitation and maintenance of grounds.
8. Hospital.
9. Company kitchens and rest rooms.

The graphical and tabular cost data for individual

products will now be discussed. For each graphic chart there appears a corresponding numerical tabulation that in most instances gives the cost of raw materials, output of product for the period, and the chemical efficiency of the process, in addition to the cost analysis by major expense items.

NITRIC ACID PRODUCTION

Nitric acid was prepared from sodium nitrate by the old reaction of Basil Valentine, $\text{NaNO}_3 + \text{H}_2\text{SO}_4 = \text{NaHSO}_4 + \text{HNO}_3$, in which the theoretical ratio of raw materials is 1 part of sodium nitrate to 1.15 parts of sulphuric acid. Considerably less than the theoretical proportion of acid was used, however, in order to obtain a satisfactory and easily-handled niter-cake. For example, at plant CH the ratio of sodium nitrate to 93 per cent sulphuric acid was 1 to 1.02 or 1 to 0.95 on a strict stoichiometric basis. The above reaction will go to practical completion at 200 deg. C. or less, and consequently it is preferable to the reaction, $2\text{NaNO}_3 + \text{H}_2\text{SO}_4 = \text{Na}_2\text{SO}_4 + 2\text{HNO}_3$, which requires a temperature of about 900 deg. C. for completion.

Fuel consumption depends considerably upon the furnace design and the skill of the operator, but with a good quality of coal, the ratio of fuel to nitric acid produced should be from 1 to 6 to 1 to 5. Labor charges per ton of product will depend on the size of the plant and of the retorts. A decade ago, from 4,000 to 6,000 lb. of sodium nitrate was the maximum charge, but during the War retorts of 7,500 lb. capacity were used. Maintenance is an important item due to the destructive action of the raw materials and reaction products and to the cracking of the retorts. Thus it is apparent that economical nitric acid production involves exceedingly careful control of the reaction and constant attention to operating expenses.

Fig. 1 and Table 1 give the comparative costs per ton of HNO_3 at 6 plants over a period of 6 months. Pure sodium nitrate is charged at \$60 per ton NaNO_3 , and sulphuric acid at \$18 per ton H_2SO_4 . An allowance of 2 per cent on the gross weight is made on sodium nitrate to cover losses in handling and the weight of bags. No

Table 1—Nitric Acid Production

Comparative costs per ton of HNO_3 at 6 plants for a 6-month period. H_2SO_4 is charged at \$18 per ton and NaNO_3 at \$60 per ton

Plant	CH	GA	LD	OY	PH	PY
General.....	\$10.55	\$5.64	\$8.16	\$7.80	\$8.02	\$4.07
Maintenance...	8.88	8.12	17.76	21.11	6.87	6.95
Power.....	0.66	1.43	5.53	1.83	3.12	0.84
Fuel.....	3.85	2.65	2.42	1.61	2.43	1.30
Labor.....	10.26	7.14	9.93	7.98	14.64	6.64
Sulphuric acid.	27.35	24.35	26.50	26.89	25.00	24.81
Sodium nitrate	89.30	85.30	89.30	88.25	89.75	88.70
Total.....	\$150.85	\$134.63	\$159.60	\$155.47	\$149.83	\$133.31
Output for period tons..	1,131.7	8,787.3	1,909.3	8,726	1,100.9	7,217.8
Efficiency, per cent....	90.7	94.8	90.6	91.8	90.2	91.4

credit is allowed for niter-cake, as conditions vary with respect to marketability; some factories being able to sell it, and others being compelled to discard it as a waste product.

Analysis of the comparative costs shows surprising deviations, that is a difference of 19.7 per cent in plants LD and PY, based on the lower cost. The greater part of this difference can be accounted for in general expense, maintenance and power, which is rather unexpected in view of the lesser magnitude of these items of operating expense as compared with raw material cost, which in the various plants is remarkably uniform.

In plant LD, the cost per ton of HNO_3 was the highest, or \$159.60, and the operating efficiency, based on the sodium nitrate input, was 90.6 per cent. However, plant PY was of slightly better operating efficiency, 91.4 per cent, and showed the lowest cost per ton of HNO_3 , or \$133.31. This indicates that the greatest opportunities for cost reduction were in operating items, and apparently a reasonably low standard of economy had not been attained, by plants LD and OY in particular.

It is significant that beyond a certain minimum output, increase in plant capacity does not necessarily lower costs of production. Plant PH with a production of 1,100.9 tons had a cost of \$149.83 per ton, and plant OY which produced 8,726 tons in the same period had a cost of \$155.47 per ton.

OLEUM PRODUCTION

Necessity for strong sulphuric acid in the manufacture of explosives and allied compounds makes the contact process the logical one for war and corresponding peace-time applications. The production of SO_3 proceeds smoothly according to the reaction, $2\text{SO}_2 + \text{O}_2 = 2\text{SO}_3$, in the presence of a suitable catalyst, and at temperatures favorable to the desired equilibrium. Purification of the entering gases is of utmost importance, as otherwise the contact mass is poisoned readily, with consequent serious impairment of conversion power.

In the Grillo process the contact mass comprises finely-divided platinum supported on a porous structure of calcined magnesium sulphate. The converter temperature range is from about 330 deg. C. at entrance to 430 deg. at exit. Efficiencies of from 93 to 95 per cent are common, and 97 to 98 per cent has been attained. The Tentelew process is also a single-stage conversion process. Platinum mass supported on asbestos is used as the catalyst.

In the Mannheim process, conversion takes place in two stages, iron oxide being used as the catalyst in the first stage, and platinum mass in the second stage. Between stages, the residual gases are purified and the SO_2 is scrubbed out. The temperature in the first stage

Total \$150.85		Total \$134.63		Total \$159.60		Total \$155.47		Total \$149.83		Total \$133.31	
General \$10.55		General \$5.64		General \$8.16		General \$7.80		General \$8.02		General \$4.07	
Maintenance \$8.88		Maintenance \$8.12		Maintenance \$17.76		Maintenance \$21.11		Maintenance \$6.87		Maintenance \$6.95	
Power \$0.66		Power \$1.43		Power \$5.53		Power \$1.83		Power \$3.12		Power \$0.84	
Fuel \$3.85		Fuel \$2.65		Fuel \$2.42		Fuel \$1.61		Fuel \$2.43		Fuel \$1.30	
Labor \$10.26		Labor \$7.14		Labor \$9.93		Labor \$7.98		Labor \$14.64		Labor \$6.64	
H ₂ SO ₄ \$27.35 1.528 Ton		H ₂ SO ₄ \$24.35 1.354 Ton		H ₂ SO ₄ \$26.50 1.472 Ton		H ₂ SO ₄ \$26.89 1.492 Ton		H ₂ SO ₄ \$25.00 1.389 Ton		H ₂ SO ₄ \$24.81 1.379 Ton	
NaNO ₃ \$89.30 1.489 Ton		NaNO ₃ \$85.30 1.423 Ton		NaNO ₃ \$89.30 1.489 Ton		NaNO ₃ \$88.25 1.470 Ton		NaNO ₃ \$89.75 1.496 Ton		NaNO ₃ \$88.70 1.477 Ton	
Plant CH		Plant GA		Plant LD		Plant OY		Plant PH		Plant PY	

Fig. 1—Nitric Acid Production

Comparative costs per ton of HNO_3 at 6 plants for a 6-month period. H_2SO_4 is charged at \$18 per ton and NaNO_3 at \$60 per ton

is about 600 deg. C. The iron oxide catalyst is relatively immune from poisoning, and can be made from the pyrites burner cinder.

Costs for one chamber-process plant have been included, but it is difficult to place the chamber and contact processes on a strictly comparable basis, as the products differ. Unquestionably for weak and moderately strong acid, up to 60 deg. Bé, the chamber process can produce H_2SO_4 more cheaply, but for 66 deg. Bé. and oleum, the contact process is admittedly the better choice. Often a combination of the two fundamental processes is good economics, and the greater the amount of H_2SO_4 made in the chamber process and without further concentration, the less will be the total cost of the entire output.

Fig. 2 and Table 2 show the comparative costs per ton of SO_3 by the Grillo process operating in three plants over a two-month period. The equivalent of pure sulphur is charged at \$22 per ton, brimstone being used largely as the raw material. An allowance of 0.7 per cent is made for losses in handling sulphur.

The lowest cost per ton of SO_3 was in plant AH for the month of June, and the highest cost was in plant GA for the same period, or a difference of 14.1 per cent based on the lower figure. In fact, plant AH easily has the most satisfactory total cost due principally to economies in maintenance and labor. There would seem to be room for improvement in the items general expense and power, however. As was noted in connection with nitric acid costs, operating efficiencies are uniformly high, and leave but little to be desired.

Output ranged over 5-fold, from 607.3 tons in June for plant AH to 3,386.5 tons for plant QY. Costs between these two plants varied 9.5 per cent for the month of June, but this is not great enough to be of any particular significance.

In general, maintenance and labor are high in plant GA; power is high in plant QY, and general expense is high in plant AH. Raw material expense is satisfactory in all three plants, but it would appear that marked reduction in operating expense as a whole could be effected throughout.

Fig. 3 and Table 3 are related closely to the preceding

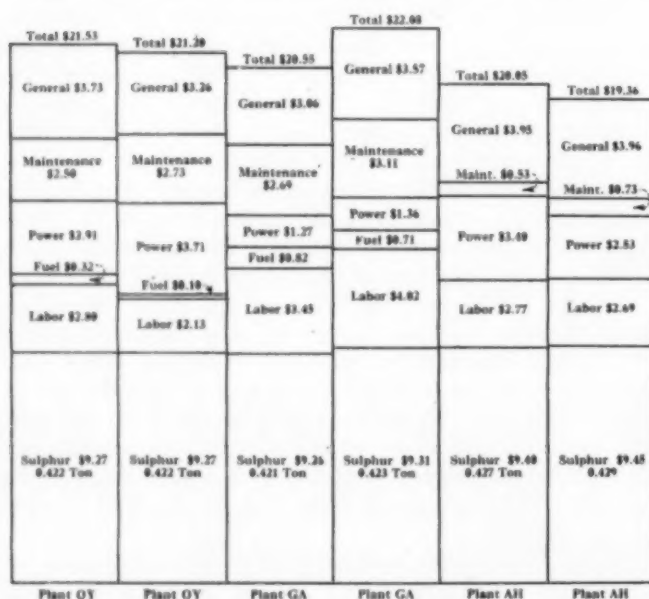


Fig. 2—Oleum Production
Comparative costs per ton of SO_3 by Grillo process in 3 plants for a 2-month period. Equivalent pure sulphur is charged at \$22 per ton

Table 2—Oleum Production
Comparative costs per ton of SO_3 by Grillo process in 3 plants for a 2-month period. Equivalent pure sulphur is charged at \$22 per ton

Plant.....	QY		GA		AH	
	May	June	May	June	May	June
General.....	\$3.73	\$3.26	\$3.06	\$3.57	\$3.95	\$3.96
Maintenance...	2.50	2.73	2.69	3.11	0.53	0.73
Power.....	2.91	3.71	1.27	1.36	3.40	2.53
Fuel.....	0.32	0.10	0.82	0.71	2.77	2.69
Labor.....	2.80	2.13	3.45	4.02	9.40	9.45
Sulphur.....	9.27	9.27	9.26	9.31	9.40	9.45
Total.....	\$21.53	\$21.20	\$20.55	\$22.08	\$20.05	\$19.36
Output for period, tons	3,847.7	3,386.5	2,150.8	1,476.2	739.6	607.3
Efficiency, per cent....	94.8	94.8	95.0	94.5	93.2	93.7

discussion, being comparative costs per ton of SO_3 by the Tentelew, Grillo, Mannheim and chamber processes for a 6-month period.

The variations among the several processes are sufficient to indicate a definite superiority of the Grillo contact plant over the Tentelew and Mannheim contact plants. The marked contrast in general expense, maintenance and labor are significant. There is considerable variation among plants using the Grillo process only, but even the highest of these costs does not approach the Tentelew and Mannheim figures. Chamber-process costs are not strictly comparable, unless the usual supplementary expense of concentration be included in the total. Obviously, the mere making of a ton of H_2SO_4 in the form of 60 deg. Bé. acid is accomplished most economically by the chamber process; but to produce the same quantity of compound at 98 per cent strength or greater, is another problem altogether, and on this latter basis the chamber plant might not be desirable.

Part of the superiority of the Grillo plant is accounted for in chemical efficiency; for the Grillo plant this is about 94 per cent, whereas for the Tentelew and Mannheim plants the figure is but 84 per cent. The range of capacity for the plants chosen would seem to be fair enough for comparative purposes.

When strong sulphuric acid is to be obtained from the chamber process, or when weak acid is to be recov-

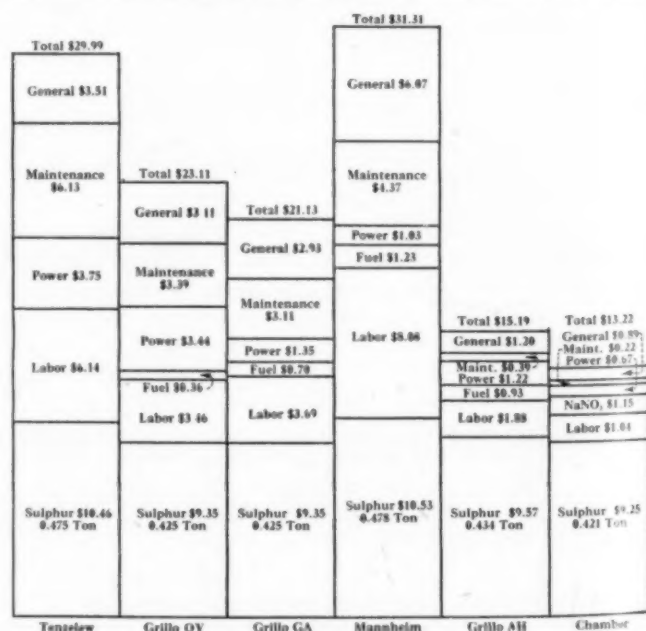


Fig. 3—Oleum Production
Comparative costs per ton of SO_3 by the Tentelew, Grillo, Mannheim and chamber processes for a 6-month period.

ered, special means for concentration must be employed. Mechanically the simplest of these processes is concentration in silica dishes arranged in cascade, the acid flowing from dish to dish in counter-current to flue gas, heat from which is transmitted through the dishes. Necessarily heat transfer by this means is poor, and the fuel consumption is therefore comparatively high. Breakage of the dishes is also an important item in operating costs. However, the product is pure, as there is neither contamination from flue gas nor from the dishes.

In the Kessler concentration system, acid vapor is generated from a base pan and hot flue gases pass upward through a tower of closely-packed volvic lava and in counter-current to the weak acid, which absorbs the vapors and loses water simultaneously, the final product flowing from the base of the tower and into a cooler. Thus the Kessler system is in reality a packed column such as is used commonly in absorption practice.

Table 3—Oleum Production

Comparative costs per ton of SO_2 by the Tentelew, Grillo, Mannheim and chamber processes for a 6-month period. Equivalent pure sulphur is charged at \$22 per ton.

Plant.....	PY	QY	GA	OY	AH	AC
Process.....	Tentelew	Grillo	Grillo	M'nheim	Grillo	Chamber
General.....	\$3.51	\$3.11	\$2.93	\$6.07	\$1.20	\$0.89
Maintenance...	6.13	3.39	3.11	4.37	0.39	0.22
Power.....	3.75	3.44	1.35	1.03	1.22	0.67
Fuel.....		0.36	0.70	1.23	0.93	
Labor.....	6.14	3.46	3.69	8.08	1.88	1.04
Sulphur.....	10.46	9.35	9.35	10.53	9.57	9.25
Sodium nitrate						1.15
Total.....	\$29.99	\$23.11	\$21.13	\$31.31	\$15.19	\$13.22
Output for period, tons.	6,333.8	25,288.3	12,342.3	1,307.7	3,797.8	.....
Efficiency, per cent.....	84.2	94.1	94.1	83.7	92.8	95.0

In the Gaillard system, dilute acid is sprayed in at the top of a tall empty tower, in counter-current to hot flue gas from a generator. The gas, mist and vapors pass out the top of the tower and thence to a "recuperator" in which most of the acid mist is scrubbed in counter-current with an acid spray. The remaining acid vapors and mists are removed in a coke-filled scrubber which is in series with the recuperator. The Gaillard tower is economical for large outputs of strong acid, but the product is usually dark-colored owing to contamination by the flue gas. The controlling advantages are (1) simplicity of construction, and (2) low fuel costs due to efficient heat transfer between gas and liquid in the concentrating tower.

Concentration Costs.—Fig. 4 and Table 4 relate to comparative costs per ton of concentrating weak sulphuric acid to 100 per cent H_2SO_4 by the cascade, Gaillard and Kessler systems. The operating period covered is one month and the loss of H_2SO_4 is charged at \$18 per ton. The superiority of the Gaillard tower and Kessler systems over the cascade system in every plant is significant. Allowing for variations in the composition of the feed and products, it is fair to conclude that concentration in cascade costs from 50 to 100 per cent more than in well-designed towers of the Gaillard type.

Concentration by the cascade system was excessively costly in plant GD, but it should be added that the total of \$13.15 per ton included evaporating a 45 per cent solution of H_2SO_4 to about 84 per cent, and in addition, part of this concentrated product was carried further to a composition of 95 per cent of H_2SO_4 . Hence costs in plant GD are not strictly comparable with those for cascade operation in other plants.

Table 4—Sulphuric Acid Concentration

Comparative costs per ton of acid concentrated and delivered at H_2SO_4 by the cascade, Gaillard and Kessler systems for one month. Loss of H_2SO_4 is charged at \$18 per ton

Process.....	Cascade	Gaillard	Kessler	Cascade	Gaillard	Cascade
General.....	\$1.07	\$0.70	\$0.71	\$1.56	\$0.95	\$2.31
Maintenance...	2.17	2.05	1.87	3.46	1.44	3.59
Power.....	0.75	0.53	0.52	1.66	0.22	0.83
Fuel.....	2.79	1.41	1.39	1.51	0.94	2.56
Labor.....	1.54	0.61	0.68	0.73	0.72	3.01
Sulphuric acid loss.....	1.30	0.68	0.83	1.30	0.65	0.85
Total.....	\$9.62	\$5.98	\$6.00	\$10.22	\$4.92	\$13.15
Output for period, tons.	1,144.8	21,953.5	26,830.5	410.0	2,183.2	2,531.2
Ave. composition charge per cent H_2SO_4	67.0	70.4	71.8	.....	.....	45.0
Ave. composition output per cent H_2SO_4	93.0	92.8	92.3	.....	.....	84.0
Efficiency, per cent.....	93.2	96.3	95.6	93.2	96.4	95.5

Efficiencies of 97.5 to 99.0 per cent have been observed in two plants using Gaillard towers, and 96.4 per cent appears to be a reasonable standard for average performance. Kessler and cascade system efficiencies were slightly lower, although the difference is hardly sufficient to warrant any definite conclusions. Differences of 5 per cent could easily be accounted for in operation depending upon variables not inherent in the process itself.

The striking feature of concentration costs by all the systems is the magnitude of general expense and maintenance, particularly the latter. Incidentally, the difficulty of obtaining suitable materials of construction for this unusually severe service indicates the desirability of further research on high-temperature acid corrosion.

Fuel costs should be in proportion to the heat necessary to increase the concentration of H_2SO_4 from one level to another and hence economy in this item is a matter of individual calculation. The wide variation in fuel costs shows that considerable opportunities for reduction exists, even allowing for the difference in standards which have been set up for each type of concentrator. According to Levy, the lowest fuel consumption is attained in the Kessler concentrator, by which one ton of 95 per cent of H_2SO_4 can be obtained from a 65 per cent feed with 200 to 300 lb. of fuel of

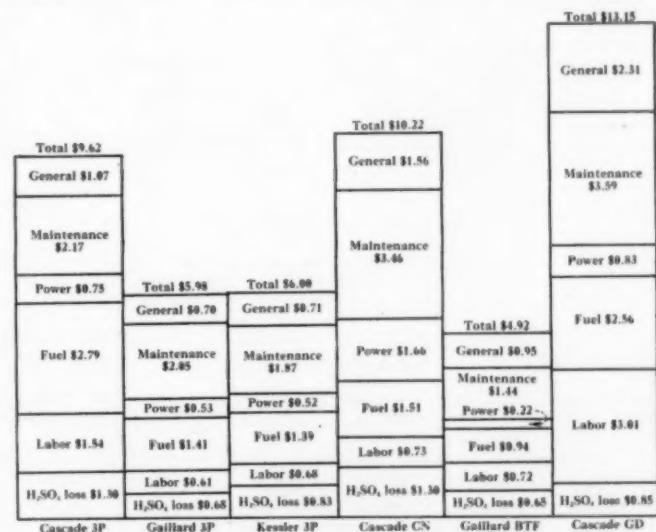


Fig. 4—Sulphuric Acid Concentration

Comparative costs per ton of acid concentrated and delivered at H_2SO_4 by the cascade, Gaillard and Kessler systems for one month. Loss of H_2SO_4 is charged at \$18 per ton

12,000 B.t.u. calorific value. Under similar conditions, the Gaillard tower would require from 300 to 400 lb. of fuel, and at best the cascade system would require from 400 to 500 lb., a quantity that generally is exceeded in practice. Obviously, the high fuel requirement of the cascade system is inherent in the wasteful mechanism of heat transfer from hot flue gas to the liquid through the dishes. Speaking generally, the variations in concentrating costs in these plants are far too great, denoting a lack of proper development work.

TRINITROTOLUOL PRODUCTION

Trinitrotoluol was made by the two-stage process, that is by nitrating toluol with relatively weak mixed acid at 50 to 70 deg. C., the reaction being, $C_6H_5CH_3 + HNO_3 = C_6H_4CH_3NO_2 + H_2O$. This mononitrotoluol is then dissolved in strong sulphuric acid and is nitrated further by agitating with strong mixed acid at a temperature of about 110 deg. C., the second reaction being, $C_6H_4CH_3NO_2 + 2HNO_3 = C_6H_2CH_3(NO_2)_3 + 2H_2O$.

Fig. 5 and Table 5 show the comparative cost per ton of trinitrotoluol in 6 plants for a 6-month period. Toluol is charged at \$90 per ton, H_2SO_4 and oleum at \$18 per ton, and HNO_3 at \$135 per ton.

In sharp contrast to data previously analyzed, the figures for trinitrotoluol show fairly uniform total operating charges, the variation in over-all cost being due principally to differences in the amount of chemicals required. On the normal basis, the cost of HNO_3 used includes a proportionate share of denitration expense, and also of the nitric acid made at the plant and charged at the comparative cost of production of \$135 per ton. Likewise the H_2SO_4 used includes a proportionate share of denitration and concentration expense, and the loss of H_2SO_4 is charged at \$18 per ton. Fig. 5 is a graphic analysis for the component operations of acid mixing, nitration and finishing, plus the cost of sulphuric and nitric acids and toluol. It would be possible to give the cost of production on the ultimate basis, that is, showing sodium nitrate, sulphuric acid and toluol as the raw materials, and adding to the above operations, the cost of making the nitric acid consumed and denitrating and concentrating the waste

Total \$365.48		Total \$318.47		Total \$323.91		Total \$321.46		Total \$307.25		Total \$303.00	
General \$28.88		General \$13.60		General \$22.12		General \$13.60		General \$21.45		General \$21.62	
Maintenance \$26.25		Maintenance \$16.25		Maintenance \$15.83		Maintenance \$15.83		Maintenance \$21.45		Maintenance \$23.85	
Power \$19.65		Power \$21.10		Power \$13.25		Power \$14.40		Power \$15.05		Power \$10.86	
Labor \$32.30		Labor \$24.00		Labor \$19.50		Labor \$24.10		Labor \$30.80		Labor \$25.45	
HNO ₃ \$157.00 1.164 Ton		HNO ₃ \$159.70 1.184 Ton		HNO ₃ \$146.80 1.082 Ton		HNO ₃ \$141.50 1.047 Ton		HNO ₃ \$144.00 1.071 Ton		HNO ₃ \$135.60 1.005 Ton	
H ₂ SO ₄ \$63.90 0.522 Ton		H ₂ SO ₄ \$39.42 0.533 Ton		H ₂ SO ₄ \$62.71 0.512 Ton		H ₂ SO ₄ \$43.50 0.383 Ton		H ₂ SO ₄ \$26.93 0.513 Ton		H ₂ SO ₄ \$41.09 0.363 Ton	
Toluene \$45.50 0.505 Ton		Toluene \$44.40 0.493 Ton		Toluene \$44.50 0.494 Ton		Toluene \$43.70 0.484 Ton		Toluene \$44.50 0.493 Ton		Toluene \$42.90 0.477 Ton	
Plant LD		Plant PH		Plant CH		Plant OY		Plant PY		Plant QY	

Fig. 5—Trinitrotoluol Production

Comparative costs per ton of trinitrotoluol in 6 plants for a 6-month period. Toluol is charged at \$90 per ton, H_2SO_4 and oleum at \$18 per ton and HNO_3 at \$135 per ton

Table 5—Trinitrotoluol Production

Comparative costs per ton of trinitrotoluol in 6 plants for a 6-month period. Toluol is charged at \$90 per ton, H_2SO_4 and oleum at \$18 per ton and HNO_3 at \$135 per ton

Plant	LD	PH	CH	OY	PY	QY
General	\$20.88	\$13.60	\$22.12	\$32.81	\$21.62	\$23.20
Maintenance	26.25	16.25	15.83	21.45	23.85	23.90
Power	19.65	21.10	13.25	14.40	15.05	10.86
Labor	32.30	24.00	19.50	24.10	30.80	25.45
Nitric acid	157.00	159.70	146.00	141.50	144.60	135.60
Sulphuric acid	63.90	39.42	62.71	43.50	26.93	41.09
Toluol	45.50	44.40	44.50	43.70	44.40	42.90
Total	\$365.48	\$318.47	\$323.91	\$321.46	\$307.25	\$303.00
Output for period, tons	1,980.6	990.6	1,059.7	7,775.3	4,450.2	14,985.0

acid, but in such a statement, operating costs for the two processes are combined and consequently much information is hidden.

As raw material costs form such a large proportion of the total, economy of these is of the greatest interest. For toluol, a consumption of 0.477 ton per ton of product is considered excellent, and this figure was attained from the 6-month period in plant QY. The other plants are considerably higher, notably LD with a consumption of 0.505 ton of toluol per ton of product.

As regards H_2SO_4 consumption, 0.320 ton per ton of product is obtainable under good conditions. Plant QY is again low with 0.363 tons, and plant PH is highest with 0.532 ton, which is very poor. It will be noted that the cost charge to H_2SO_4 is not that of the acid alone, but includes a proportion of denitration and concentration expense as well. This explains the excessive H_2SO_4 expense at plants LD and CH, in which heavy nitration losses occurred. Conversely, the excellent H_2SO_4 economy at plant PY is traceable to efficiency in concentration and denitration.

Nitric acid consumption is the controlling factor in cost, being the largest single item of expense, and normally it should be about one-half of the total cost of production. A consumption of 0.975 ton of HNO_3 per ton of product can be attained, and for the 6-month period, plant QY nearly approached this figure, with 1.005 tons. Plant PH, with a consumption of 1.184 tons HNO_3 , was inordinately high due largely to residues in distillation. That is, the quantity of HNO_3 consumed is the sum of that used in the nitration reaction plus that lost at the retorts and denitrators. Efficient treatment of waste acid is, therefore, of the greatest importance as the records of plants PH and LD show.

In the comparison of total trinitrotoluol costs, it should be said that plant QY used fresh mixed acid for making mononitrotoluol, and that plant PY used fortified trinitrotoluol spent acid for the same purpose.

Inspection of operating expenses shows that although the totals do not compare with those for raw materials, the variations among different plants are considerable. For example, general expense is \$13.60 at plant PH and \$32.81 at plant OY; maintenance is \$16.25 at plant PH, and \$26.25 at plant LD; power is \$10.86 at plant QY and \$19.65 at plant LD; and labor varies from \$19.50 at plant CH to \$32.30 at plant LD. The foregoing variations indicate opportunities for considerable cost reduction. The minimum costs do not occur at any one plant, and furthermore the two smallest plants have the lowest operating expense per ton of product; which is contrary to the usual cost theorem regarding unit costs as a function of plant size. For example, at plant CH the total of general expense, maintenance, power and labor is \$70.70 per ton of product; and at

plant LD which has nearly twice the output the same items total \$99.08 per ton of product, or a difference of \$28.38 per ton. This illustrates the great possibilities of cost reduction by budgeting expense on the basis of comparative performance. Had the operating expenses per unit been the same at plant LD as at plant CH, the annual savings would have been \$112,500.

Table 5a—Trinitrotoluol Production: Ratio of Labor per ton of Daily Output

Plant	Monthly Production, Tons	Number of Employees	Daily Production, Tons	Employees per Ton of Daily Product
CH.....	212.4	112	6.07	18.5
LD.....	341.8	117	9.77	12.0
OY.....	1,185.0	672	33.86	19.8
PY.....	740.1	332	21.14	15.7
PA.....	225.2	58	6.43	9.01

Table 5a shows the labor requirements for trinitrotoluol manufacture. The maximum ratio is 19.8 to 1 at plant OY, the minimum is 9.01 to 1 at plant PH and the mean ratio is 15.0 to 1. Labor includes that for acid mixing and all finishing processes. The high ratio of labor per ton of daily product is in marked contrast to nitric acid and sulphur trioxide manufacture.

NITROGLYCERINE PRODUCTION

Nitroglycerine or glycerol trinitrate, was made by the careful nitration of pure glycerol with strong mixed acid at about 18 deg. C. in accordance with the equation, $C_3H_8(OH)_3 + 3HNO_3 = C_3H_5(NO_3)_3 + 3H_2O$. As this reaction is strongly exothermic, ample cooling surface must be provided, and reaction control within narrow temperature limits is essential. Comparative costs per ton of nitroglycerine production in 3 plants over a period of 2 months are shown in Fig. 6 and Table 6. Glycerine is charged at \$450 per ton, oleum and H_2SO_4 at \$18 per ton, $NaNO_3$ at \$60 per ton, and HNO_3 at \$135 per ton. All three plants are of the same order of magnitude as regards output, PY and CN being practically identical in size, and GA having an output of

about four times either PY or CN. Curiously enough plant GA has the largest unit production cost.

The chemical yields, expressed in per cent and based on the glycerine, were remarkably uniform in all three plants. The highest yield figure at plant PY was 230.3 per cent, and the lowest at the same plant was 227.6 per cent. Barring unusual losses, uniformity of yields should be the rule, as a product of definite chemical composition is being manufactured, and under conditions very carefully controlled.

Of the processes studied in this series, nitroglycerine manufacture is unusual in that the ratio of operating expense to raw material costs is so small. At plant PY, which on the basis of the data shown, appears to represent average practice, the total of general expense, maintenance, power and labor during March was \$51.52, or 13.3 per cent of the total production cost. Plant GA has the highest unit operating expense, \$87.35, or 21.3 per cent of the total cost, and plant CN has the lowest unit operating expense, \$17.69, or 5.08 per cent of the total cost. Contrast this with contact sulphuric acid manufacture, Fig. 2, in which the unit operating expense varied from 51.3 to 57.8 per cent of the total production cost. A still greater extreme is illustrated by electrolytic ammonium perchlorate manufacture, in which operating expense varied from 90 to 95 per cent of the total cost—about the inverse of good practice in nitroglycerine manufacture.

Examining now component costs at the 3 plants, we find that plant GA has the best raw material economy, and this advantage is more than offset by excessive operating expense, the net result being a total cost per ton of product of \$408.93 during April. A total cost of \$352.36 was attained by plant CN during the same month, due entirely to low operating expense, and this

Table 6—Nitroglycerine Production

Comparative costs per ton of nitroglycerine in 3 plants for a 2-month period. Glycerine is charged at \$450 per ton, oleum and H_2SO_4 at \$18 per ton, $NaNO_3$ at \$60 per ton and HNO_3 at \$135 per ton

Plant.....	PY		GA		CN	
	March	April	March	April	March	April
General.....	\$6.82	\$6.73	\$24.51	\$29.60	\$8.93	\$16.50
Maintenance...	16.20	19.61	9.82	11.69	2.29	1.41
Power.....	13.60	13.70	13.63	13.36	.....	.....
Labor.....	14.90	13.56	27.00	32.70	6.47	7.18
Nitric acid.....	121.40	120.60	118.40	117.60	117.60	118.80
Sulphuric acid	18.84	18.13	11.17	8.38	19.21	14.87
Glycerine.....	195.50	197.80	195.60	195.60	193.60	193.60
Total.....	\$387.26	\$390.13	\$400.13	\$408.93	\$348.10	\$352.36
Output for period, tons.	185.2	174.3	865.4	735.8	205.7	190.8
Yield on glycerine, per cent.....	230.3	227.6	229.9	230.0	228.9	230.0

Total \$387.26 General \$6.82		Total \$390.13 General \$6.73		Total \$400.13 General \$24.51		Total \$408.93 General \$29.60	
Maint. \$16.20	Maint. \$19.61	Maint. \$9.82	Maint. \$11.69	Total \$348.10 General \$8.93		Total \$352.36 General \$16.50	
Power \$13.60	Power \$13.70	Power \$13.63	Power \$13.36	Maint. \$2.29		Maint. \$1.41	
Labor \$14.90	Labor \$13.56	Labor \$27.00	Labor \$32.70	Labor \$6.47		Labor \$7.18	
HNO ₃ , \$121.40 0.899 Ton		HNO ₃ , \$120.60 0.892 Ton		HNO ₃ , \$118.40 0.877 Ton		HNO ₃ , \$117.60 0.870 Ton	
H ₂ SO ₄ , \$18.84		H ₂ SO ₄ , \$18.13		H ₂ SO ₄ , \$11.17		H ₂ SO ₄ , \$8.38	
Glycerine \$195.50 0.434 Ton		Glycerine \$197.80 0.439 Ton		Glycerine \$195.60 0.435 Ton		Glycerine \$193.60 0.43 Ton	
Plant PY March	Plant PY April	Plant GA March	Plant GA April	Plant CN March	Plant CN April		

Fig. 6—Nitroglycerine Production

Comparative costs per ton of nitroglycerine in 3 plants for a 2-month period. Glycerine is charged at \$450 per ton, oleum and H_2SO_4 at \$18 per ton, $NaNO_3$ at \$60 per ton and HNO_3 at \$135 per ton

excellent performance is a standard which should at least be approached by plants PY and GA.

In the cost tables for plant CN, the item power, which appears separately elsewhere, is included in the item general expense. Maintenance expense is extremely variable being \$19.61 at plant PY during April, and only \$1.41 at plant CN. During the same period labor was \$32.70 at plant GA, and \$7.18 at plant CN. Doubtless a careful process survey at plant GA would have revealed the cause for such high operating expense, which is particularly unfortunate as this plant has about four times the normal output of either plant PY or plant CN. Thus the magnitude of the "multiplying factor" in production is a guide to the real importance of cost reduction in any given plant.

Institute of Chemical Engineers Confers on Education

Editorial Staff Report

MEETING under the auspices of the American Institute of Chemical Engineers, educators discussed fully the important phases of professional training for chemical engineers at an open conference held at Columbia University, New York City, on Friday, March 26. During the meetings and at luncheon, members of the conference were the guests of the University.

The principal topics of discussion were as follows:

(1) "Chemical Engineering—What It Is and What It Is Not," by Arthur D. Little, president, Arthur D. Little, Inc.; (2) "The Curriculum," by W. L. Badger, professor of chemical engineering, University of Michigan; (3) "Entrance Requirements," by J. H. James, head, Department of Chemical Engineering, Carnegie Institute of Technology; (4) "Qualifications of Faculty," by W. K. Lewis, head, Department of Chemical Engineering, Massachusetts Institute of Technology; (5) "Length of Course," by D. D. Jackson, executive officer, Department of Chemical Engineering, Columbia University, and James R. Withrow, professor of chemical engineering, Ohio State University; (6) "Chemical Engineering Laboratory," by A. W. Hixson, professor of chemical engineering, Columbia University; (7) "Local Administration," by Harry A. Curtis, professor of chemical engineering, Yale University, and S. W. Parr, professor of applied chemistry, University of Illinois. H. C. Parmelee, editor of *Chem. & Met.*, was chairman of the conference.

In 1922 the American Institute of Chemical Engineers unanimously adopted the following definition of chemical engineering:

Chemical engineering, as distinguished from the aggregate number of subjects comprised in courses of that name, is not a composite of chemistry and mechanical and civil engineering, but itself a branch of engineering, the basis of which is those unit operations which in their proper sequence and co-ordination constitute a chemical process as conducted on the industrial scale.

Dr. Little, in a written communication, emphasized the point that chemical engineering is not regarded by its practitioners as a science in itself, but as a branch of engineering, which draws freely upon the sciences as its needs require. Of the differences between industrial chemistry and chemical engineering, he said in part:

Industrial chemistry is concerned primarily with general processes and products, and it very commonly happens that the industrial chemist soon comes to specialize upon one process leading to a single line of products. Chemical engineering, on the other hand, as pointed out in the Report just mentioned, recognizes that all the processes of industrial chemistry may be resolved into a co-ordinated series of unit operations and that processes vary among themselves in the nature and number of unit operations involved and the order of their sequence.

In reviewing the contents of various college courses in chemical engineering, Professor Badger showed that it was practically impossible to make a fair comparison among the different schools, because of complications in nomenclature. For example, subjects such as industrial chemistry, chemical engineering, chemical engineering laboratory, physical chemistry, etc., have entirely different meanings in different schools.

It is probable that as a result of Professor Badger's study, the Institute will appoint a committee or a sub-

committee to investigate the whole question of a nomenclature of chemical engineering courses of study.

In discussing the question of entrance requirements for courses in chemical engineering, Professor James emphasized the lowering of academic standards that has come about as a result of the mass education system in secondary schools. To quote in part from Professor James:

Veteran teachers tell us in no uncertain terms that the preparation for college as carried out by the public high schools is not as good as it was twenty years ago. Then to get the same results from year to year in college, i.e., to hold to the same standards, the student mortality increases.

Professor Lewis, in specifying qualifications of faculty said that technical ability in the teacher of engineering was necessary, but that it was merely a prerequisite and to other qualifications we must attach the highest importance. For example, the successful teacher must have sustained contact with industrial work, he must have an inspiring personality, he must have breadth of vision, enthusiasm, optimism, and finally he should possess in a high degree the qualities of mental alertness and flexibility of mind.

With regard to length of course, Professor Jackson said that unquestionably there was room for four, five, six, and even longer courses depending upon the course outlined, and the character of the men to be trained. The opinion of Professor Withrow and of the conference seemed to be that the four-year course would continue to predominate and that due to economic limitations of the students it was impossible to standardize on a longer course.

In outlining instruction in chemical engineering laboratory, Professor Hixson stressed the development of initiative in the student. The laboratory course in chemical engineering is given continuously for 6 weeks during the summer following the student's second professional year. During the six weeks the student is occupied continuously with this course which comprises the economic and technical problems connected with semi-factory scale operation and the basic operations of chemical engineering, that is, filtration, evaporation, distillation, crushing and a number of the others. The students organize themselves, and proceed under general directions only, which are subject to discussion as the work proceeds. Everything is planned toward one end—that is, encouraging the quality of initiative in the student.

Local administration was discussed by Professors Curtis and Parr. Professor Curtis believed that the most satisfactory arrangement was one whereby the chemical engineering department was administered by a separate head, and in the school of engineering. However, he said that very close contact should be maintained with the department of chemistry, and he deplored the desire of some heads of departments to part company with chemistry, the parent science of chemical engineering.

Professor Parr believed that the real demand of industry today is for men capable of undertaking investigational or development or research work. He went on to say that the department of chemistry is the proper source of such training.

Fifty-two delegates and visitors, representing 30 educational institutions, attended the conference. A full account of the proceedings will appear in the regular Transactions of the American Institute of Chemical Engineers.

Lubrication Symposium at Tulsa

American Chemical Society discusses fundamental properties of lubricating oils and their application

By D. P. Barnard, 4th

Standard Oil Company of Indiana
Whiting, Indiana

THE FIRST symposium on lubrication was held on April 6 and 7 at the Hotel Mayo in Tulsa, Oklahoma as part of the American Chemical Society's spring meeting program. The symposium was made possible through the cooperating of the Petroleum, Industrial and Engineering Divisions of the Society. The program was arranged by Robert E. Wilson, chairman of the symposium.

In order to familiarize those present with the activities of various organizations in this country, H. A. S. Howarth of the Kingsbury Machine Works gave a short talk summarizing the work of the American Society of Mechanical Engineers' Research Committee on Lubrication. Particular attention was called to the research program dealing with bearing metals and also Mr. Howarth's own division dealing with the fundamental aspects of lubrication.

The first technical paper was presented by D. P. Barnard of the Standard Oil Co. of Indiana, in which was given an exposition of the fundamental laws of lubrication in their simplest form. The effects of changes in such fundamental factors as rubbing speed, load, and oil hole location were demonstrated by means of a motion picture study of the flow of oil through a glass bearing. This was followed by Mr. Howarth's technical paper in which the fundamental laws of complete and various types of partial bearings were developed and illustrated in detail. This paper represented the results of a number of years of study by Mr. Howarth and included a complete graphical analysis of fluid film lubrication in virtually every important form of cylindrical bearing.

The next three papers dealt with another phase of lubrication, one in which even the simplest fundamental problems remain for the most part virtually unsolved. A paper by W. C. Wilharm, of the Westinghouse Electric Co., described the results of a considerable amount of work dealing with "oiliness" and its measurement. C. E. Gilson, of the General Electric Laboratories at Schenectady gave an account of some experiments in which it was found that temperature and atmospheric conditions exerted a marked and unexplainable effect on the friction in a bearing operating wholly in the fluid film range. In these tests, the conditions were purposely adjusted so that the lubricating films were much thicker than normally occur. Another phase of surface action in lubrication was described by A. E. Becker, of the Standard Oil Co. of New Jersey. Dr. Becker, however, studied the surface effects in cases in which the oil films were extremely thin. His work showed strikingly the difference between true bearing metals and materials such as aluminum in their abilities to support a lubricating film. For instance, it was found that cast iron would maintain a far thicker film than would magnesium under similar conditions.

Two very interesting papers dealing with Diesel engine lubrication were next presented. The first, by P. L. Scott of Chicago, described many of the detailed prob-

lems to be met in the lubrication of large Diesel engines and offered a number of suggestions for overcoming some of the more important difficulties. A specific case of Diesel cylinder trouble and the means employed in producing a satisfactory power plant from one in which frequent serious overhauls were a necessity was described by R. R. Mathews and F. Norton of the Roxana Petroleum Corporation.

S. W. Sparrow and J. O. Eisinger of the Bureau of Standards next presented information obtained in the course of the Cooperative Fuel Research being supervised by the Bureau. A number of tests dealing with the crankcase dilution problem in automotive engines were described, particular emphasis being placed on the tendency of the amount of dilution to build up to an equilibrium value which depends, of course, on operating conditions. Of especial interest was the account of some cranking effort tests in which it was found that the "break-away" torque required to start an engine was markedly reduced by the addition of oleic acid to the lubricant to increase its oiliness. A paper by R. E. Wilson and R. E. Wilkin, of the Standard Oil Co. of Indiana, described the method of development and particular advantages of the new "non-diluting" equilibrium type of motor oil. In this oil a base of rather high viscosity is initially blended with approximately 10 per cent of a special fraction having the composition of the heavy ends normally condensing from gasoline vapor. This oil has the property of permitting easy cranking under all conditions and of being much less liable to take up additional diluent than the conventional type of oil. Another recent development in internal combustion engine lubrication was presented by T. C. Coleman and A. W. Pope, of the Waukesha Motor Co., who gave an account of the new "fresh" oil system of cylinder lubrication in which an accurately metered and timed portion of oil is supplied to each individual cylinder. C. T. Livingstone, S. P. Marley, and W. A. Gruse, of the Bureau of Mines, reported a series of very carefully conducted comparative carbonization tests on motor oils in which it was found that the carbonization characteristics of the oil are very closely parallel to their Conradson carbon residue test values.

A paper by L. W. Parsons and G. R. Taylor, of the Tide Water Oil Co., presented the results of tests on the oxidation and emulsification properties of turbine and motor oils, their fluid characteristics at low temperatures and "oiliness" as measured by static friction. A series of friction experiments with lubricants containing graphite in suspension was described by F. L. Koethen, of the Acheson Graphite Co. In two series of tests, one using a rotating journal and the other a weighted slider, lower friction was obtained in the regime of metallic contact when graphite was present. A paper was also given by M. V. Dover, of the University of Missouri, in which some of the earlier work of Wilson and Barnard on oiliness was duplicated under a wider range of conditions. Several new features were brought out, especially the "latent period" in the experiments in the clogging of metal capillaries of small bore. The various properties of the oils examined were compared with their oiliness values as determined with the Deeley friction machine. The final paper on the symposium program was given by B. T. Brooks, of New York, in which the properties of oils prepared by the vacuum distillation process were discussed.



Fig. 1—A section through the Marland refinery at Ponca City, Okla., where a \$1,000,000 construction program is now in progress.

A new power plant is shown at the right and at the left are the continuous crude oil stills. A portion of the large tank farm that will store 10,000,000 bbl. of oil is to be seen in the background.

Keeping Pace with Progress in Petroleum Refining

Continuous extensions and improvements have made the Ponca City plant of the Marland Refining Company a reflection of the latest developments

By Sidney D. Kirkpatrick

Associate Editor, Chem. & Met.

EDITOR'S NOTE. In the Mid-Continent field the petroleum refining industry has developed under happy circumstances. Its progress has been unhampered by the precedent of a long history of conservatism or by the inheritance of obsolete processes and equipment that have sometimes handicapped the industry in other localities. The pioneering and daring policies of the oil producer find their reflection in the way the Mid-Continent refiner has tackled his problem of building plants to utilize the most modern equipment and efficient practices available. To report the progress of this development from first-hand observation is the purpose of a series of staff articles, of which this is the first.

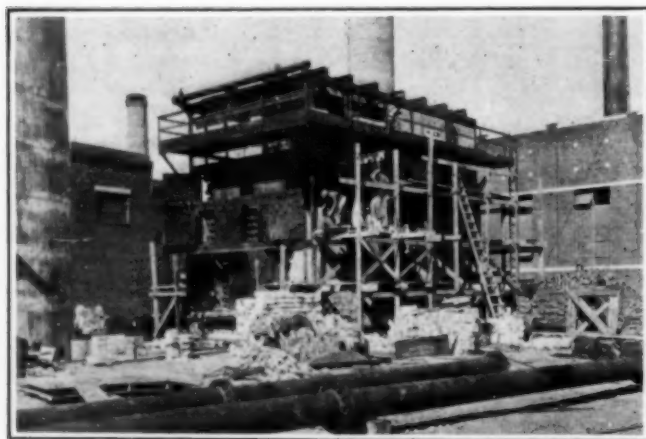


Fig. 3—Foster pipe stills under construction

Two batteries of these stills will have a charging capacity for handling 11,000 to 12,000 bbl. of crude oil per day and when connected to efficient fractionating equipment will produce a large proportion of finished products

LESS THAN ten years ago and with five shell stills as a nucleus, the Marland Refining Co. began the operation of a small skimming plant at Ponca City, Oklahoma. Since then its development has been a continuous process, acquiring in turn such other refining equipment as cracking units, lubricating oil and wax plants, until at the present time it has reached the status of a complete refinery. When, within a few months, the \$4,000,000 construction program now under way will have been completed, the Ponca City plant will completely refine 25,000 bbl. of crude oil each day and an additional 5,000 bbl. will be skimmed to produce gasoline, kerosene and fuel oil.

Crude oil is pumped to the refinery from the nearby Tonkawa, Burbank, Thomas and Kansas fields. By direct distillation this oil yields 40 to 45 per cent of gasoline of 25+ color that requires only a sweetening treatment before marketing. The subsequent steps by which the gasoline yield is ultimately increased to 70 to 80 per cent and the various other petroleum products are produced, is shown in the accompanying flow sheet—although as will be pointed out later in this article, these operations will shortly be considerably modified as the new equipment being constructed is put into use. To follow the progress of these operations, it is convenient to divide them into three units: those of the skimming or topping plants, the cracking units and the wax and lubricating oil plants.

In the present skimming plant the crude oil is distilled in two batteries consisting of 6 cylindrical stills, each battery being preceded by a pipe or tube still. In

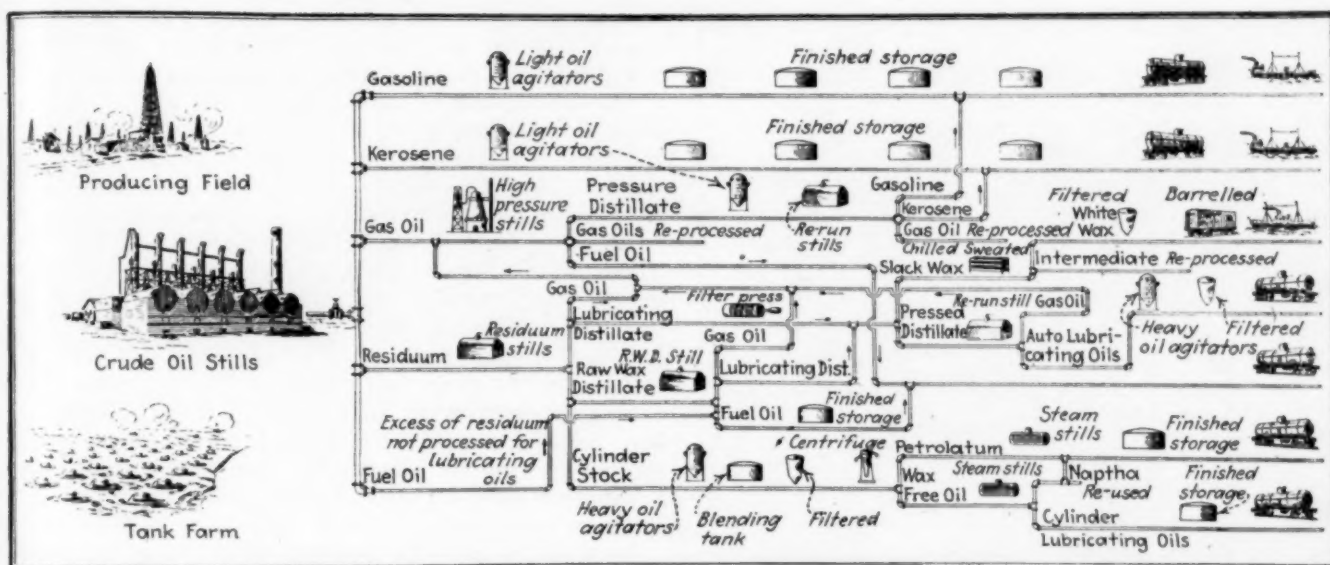


Fig. 2—A Schematic Flow Sheet Showing the Principal Steps in the Refining Operations at the Marland Refining Co. The use of new equipment and processes described in this article will change operating procedure somewhat as well as greatly increasing refining capacity

the pipe still about 20 per cent of the crude oil is vaporized, while the 6 continuous stills remove the remainder of the 70 to 75 per cent that is taken off in the form of vapors. These batteries have an approximate daily charging capacity of 20,000 bbl. The gas oil fraction from this distillation is sent to the cracking stills and subsequently returned as pressure distillate which is pumped into the top of the fractionating columns of the crude stills. In addition to acting as a reflux and conserving the heat of the system, the pressure distillate loses its gasoline content and the heavier ends are returned for distillation. By the use of such methods of efficient fractionation, the proportion of distillate that must be rerun is reduced to practically nothing, at the same time maintaining high quality in the finished products.

When the 2 Foster pipe stills, which are shown under construction in Figs. 3 and 4, are in operation, there will be an additional skimming capacity of 5,500 to 6,000 bbl. of crude oil per day for each unit. One of these will be equipped with Badger columns containing the bubble-cap type of plates and is expected to fractionate 70 to 75 per cent of the crude oil vapors into end-point gasoline, kerosene, gas oil and fuel oil residuum. The second Foster still will have a special bubble tower in which a similar fractionation of the crude oil will be carried out. Both units are equipped with liquid and vapor heat exchangers of the Braun type of construction. The light oils from the new stills are to be stored in Graver tanks provided with the Wiggins floating roofs, which are designed to reduce evaporation losses to a minimum.

MANY INNOVATIONS IN CRACKING PLANTS

The original cracking units installed by the Maryland company in the fall of 1922 were of the Fleming type. (See Brownlee's articles in *Chem. & Met.*, November and December, 1924.) The battery of 18 units, having a total charging capacity of 5,000 bbl. of gas oil per day, is shown in Fig. 5. These stills, which operate at about 100 lb. pressure, have proved efficient producers, cracking approximately 45 per cent of the gas oil into gasoline.

It is in the newer operations, however, that the company is introducing several important innovations in

the cracking art. Both the Dubbs and Cross processes are to be employed in order to handle a wide range of cracking stocks. The Cross installation, shown under construction in Figs. 6 and 7, will consist of two double units with a gross charging capacity of 4,000 bbl. of gas oil per day, from which approximately 1,400 bbl. of gasoline will be produced. The operating pressure will be 600 to 650 lb. per sq. in.

The Cross units will include reaction chambers similar to the one shown in Fig. 8, which is approximately 42 ft. long, 65 in. in outside diameter with 4-in. alloy-steel walls. It is in fact a gun forging, weighing 53

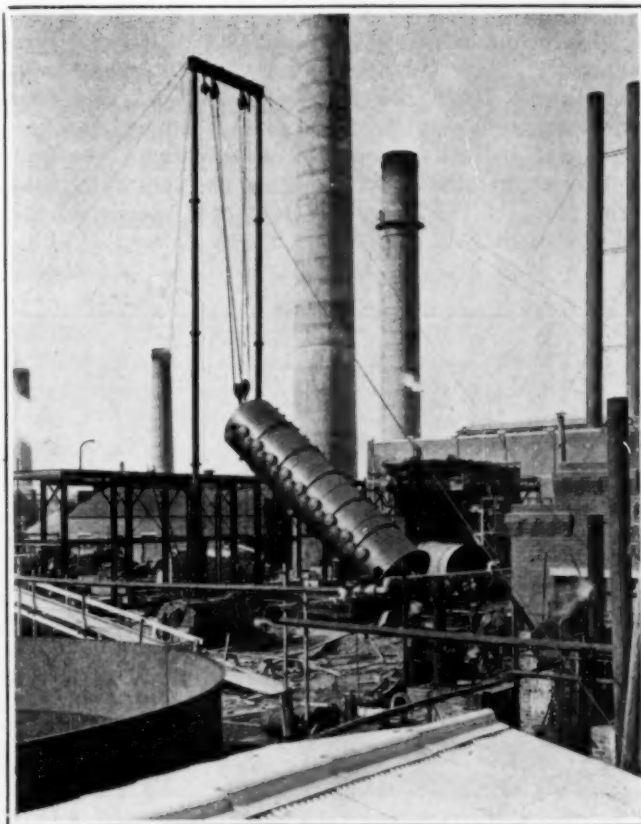


Fig. 4—Fractionating Column for Pipe Stills

These bubble towers, which are among the largest ever built will provide efficient separation of gasoline, kerosene, gas oil and residuum for fuel oil

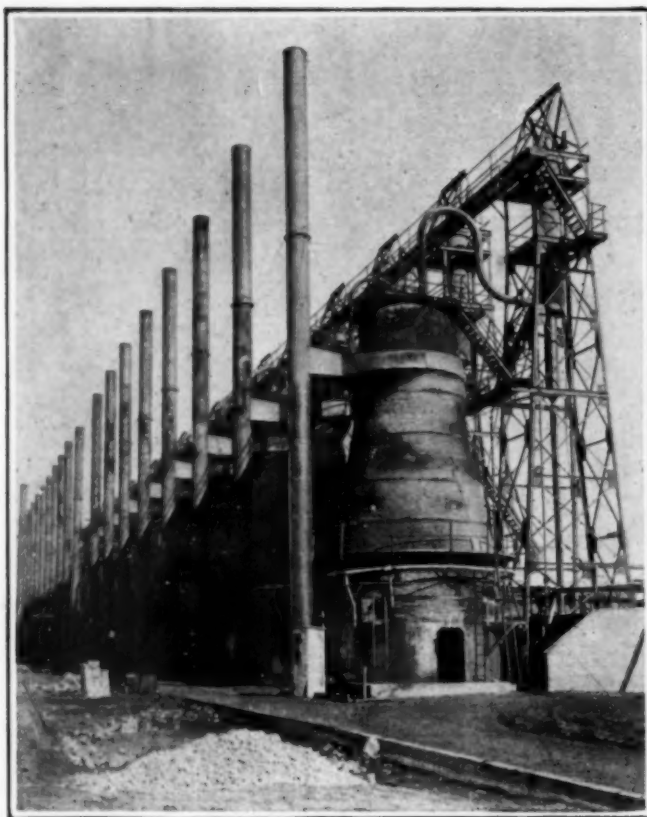


Fig. 5—Battery of 18 Cracking Units

Although units of other processes are now being installed, the Fleming installation continues to give efficient service, producing 40 to 45 per cent of gasoline from gas oil

tons, which was made in the Krupp works in Germany and imported by the M. W. Kellogg Co., the firm in charge of the erection work on the Cross units.

A significant feature will be the use of Gray treating towers in addition to the usual type of bubble tower equipment. This treatment in the vapor phase with fullers earth takes the place of the usual sulphuric acid-caustic soda treatment and gives a finished gasoline in a single operation except for sweetening. The first commercial installation of the Gray process, which was at the plant of the Barnsdall Refining Co., also in the Mid-Continent field, was described by Donald M. Liddell (*Chem. & Met.* for Dec. 22, 1924). It is probable



Fig. 6—Two Cracking Units Under Construction

Only the tube furnaces and stacks of the Cross process were in place when this photograph was taken, Feb. 20, 1926. When completed these units will include bubble cap fractionating columns and Gray towers for vapor phase refining

that the Gray towers will also be used with the Dubbs cracking stills, although experiments are still under way to determine the method of application.

The installation of the 6 Dubbs units, which are now being constructed by the Universal Oil Products Co., will have a number of interesting features. Two reaction chambers, instead of one, will be used with each unit and the size of these chambers has been increased to 10 ft. in diameter by 40 ft. in height, (see Fig. 9). These will each hold approximately 120 tons of coke and should, therefore, greatly increase the operating cycle. The dephlegmators, one of which is also shown in Fig. 9, will be the largest ever built on a Dubbs still, being 44 ft. by 4 ft. and will be equipped with Schnieble centrifugal plates which have previously been used successfully in alcohol distillation. By a special fin type of construction the vapors are given a whirling motion that promotes more efficient separation.

Each Dubbs unit has a 6-stage centrifugal pump for circulating the hot oil from the bottom of the dephleg-

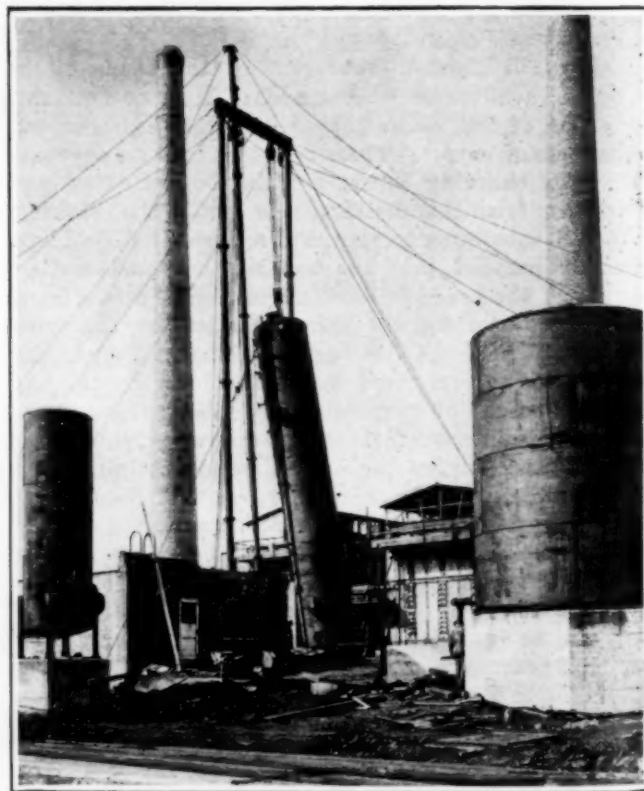


Fig. 7—Vaporizer for Use with Cross Cracking Still

mator to the furnace tubes. This pump, made by the Byron-Jackson Co., is driven by a Westinghouse steam turbine operating condensing. These units will be the first to have low mounted dephlegmators, since the necessity of maintaining a high head is done away with by the use of the centrifugal pump. The pump also greatly increases the velocity of the oil through the furnace tubes, which is expected to keep them freer from coke and, therefore, able to give longer service.

The furnaces are to have 90 tubes in each, or 28 more tubes than are to be found in the largest existing Dubbs installation. A special type of fuel economizer, which draws off a portion of the flue gases and uses them for preheating the incoming air, is expected to reduce the fuel consumption approximately 30 per cent, bringing it down to around 6 or 7 per cent of the gross oil charged.

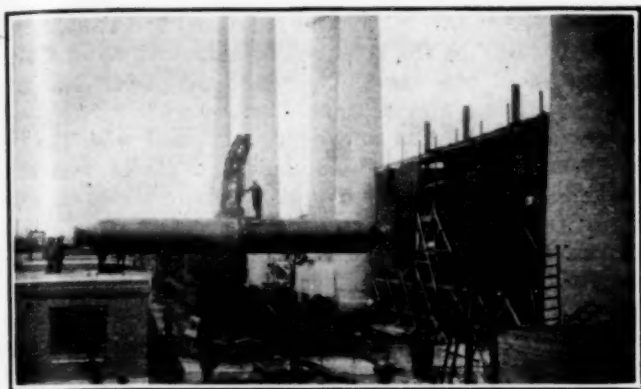


Fig. 8—Reaction Chamber for a Cross Process Plant
This forging, which is similar to one being installed at the Marland refinery, is 42 ft. long with 4-in. alloy steel walls and weighs more than 50 tons

The 6 Dubbs units will be charged with approximately 5,500 bbl. per day, of which about 30 per cent will be gas oil and 70 per cent fuel oil. The plant will operate at 180 to 200 lb., making non-residuum runs, i.e., producing only gasoline and coke. This avoids the production and subsequent disposal of the Dubbs residuum, which in the past has given some concern to Mid-Continent refiners.

LUBRICATING OIL AND WAX PLANTS

The first lubricating oil plant at Marland's was built in 1919-1920 and included a Sharples petrolatum and bright stock plant, the first to be installed in the Mid-Continent field. The wax distillate plant is of standard Vogt construction, the manufacturing steps being those already shown in Fig. 2. A feature of the plant is the use in the lubricating oil filters of fullers earth that has been obtained from the company's own deposits at Riverside, Texas. The Simonson-Mantius acid-reclaiming system installed at the Marland plant was the first in which acid was reclaimed from heavy cylinder stock sludges. Some progress has also been made, in an experimental way, in the burning of acid sludge under the crude oil stills. Corrosion difficulties so far encountered have proved insignificant.

The refinery water supply is obtained from 7 wells along the Arkansas River, which is but a short distance from the plant. About 2,000,000 gal. are pumped from the wells each day, but it is necessary for a large



Fig. 9—One of the Dubbs Cracking Units Under Construction, March 8, 1926
Three of the large size (10 ft. by 40 ft.) reaction chambers are shown in place. One of the dephlegmators—the largest ever installed on a Dubbs plant—is on its side in the foreground. It will be mounted on the supporting tower shown directly above it

portion of this to be recirculated through cooling towers and ponds. The electrically driven recirculating pumps handle 40,000 to 60,000 gal. of water per minute. The boiler-water supply is softened in Cochrane equipment by the lime and soda ash treatment.

For the privilege of visiting the plant of the Marland Refining Co., the writer wishes to express his thanks to Walter M. Miller, vice-president in charge of manufacturing. For information regarding operating procedure and for other assistance in the preparation of this article he is indebted to Harold G. Osborn of the manufacturing department and Wayne P. Rice, superintendent of the Ponca City refinery.

Special Refractory Problems

In a talk before the New York Section of the Society of Chemical Industry (London), R. H. Minton, of the General Ceramics Co., discussed some of the problems relating to refractory materials in which the chief requisite is not necessarily high temperature resistance. In certain electric furnaces refractories must possess qualities exactly opposite to those needed for other furnaces. Of course both must possess the refractoriness required but one must also possess high thermal conductivity and the other low, for one is wound on the outside and the other on the inside.

Two of the oldest problems troubling ceramists are those dealing with slabs and saggars. Slabs are 24x24x3 inches and to develop such a shape to withstand a low temperature of 1,350 deg. C. while carrying a load of 500 lb. or more, being supported only at the four corners, is difficult. The initial cost, short life and loss of ware from failures constitutes a heavy overhead kiln charge on many types of ware. Silicon carbide and alundum slabs represent the best so far developed, but these are very expensive.

Some interesting problems are encountered in the construction of furnaces and kilns, as brought out by the American Shaw Gas Kiln Co. in the construction of its compartment kiln for ceramic firing.

The first was that of the spalling of the brick in the arch, or crown. When the first kiln was built in 1922 a number of tests were made to determine the most desirable brick from the standpoint of spalling. A brick having high resistance to spalling was selected and carefully made and laid. To our amazement this brick spalled badly in use.

In the second Shaw Kiln built in this country another type of refractory was used, chosen absolutely on account of the desire of the owner to cut down the expense, and although not equal to the first as a temperature resisting material its performance in use has been excellent.

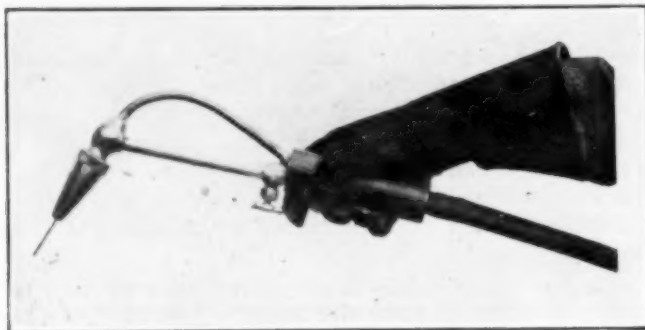
Another problem was that of a high melting refractory capable of carrying a heavy load under severe conditions. Here the load test gave us quite reliable clues. However, other conditions also had to be considered. Silica brick, which are excellent load carrying refractories, were found to be unsuitable on account of spalling, while carborundum was not desirable on account of high thermal conductivity, and its weakness in strong oxidizing atmospheres.

The third problem encountered was in maintaining straight a long wall fired to a higher temperature on one side than on the other. A fire brick wall under such conditions has a tendency to bow away from the high fire side.

Arc Welding in Hydrogen And Other Gases

Improved ductility of welds produced in an atmosphere of hydrogen shown by recent successful experiments

RESearch work conducted recently at the Thomson Research Laboratory of the General Electric Co., at Lynn, Mass., developed a method for arc welding in a hydrogenated atmosphere. The research from which this new method came was concerned with obtaining an improvement in the ductility of the deposited metal. It is difficult to obtain this because of the high temperature of the arc and the short time in which chemical reactions and solidification of metal take place. Other



Model of Torch for Arc Welding in an Hydrogenated Atmosphere

In this picture, the metallic electrode is seen extending from the torch from which the hydrogen flame is projected

investigations have shown that the ductility of the weld is limited by the presence of oxides and nitrides of iron introduced into the molten metal during the welding operation.

At the Lynn laboratory, P. Alexander carried out a systematic investigation on welds produced in various gaseous media, with the object of avoiding the presence of oxides and nitrides by the elimination of both oxygen and nitrogen in the atmosphere around the arc.

After a series of preliminary experiments with carbon dioxide, superheated steam, illuminating gas and other gaseous mixtures, pure hydrogen was tried, which at once gave excellent results. Welds produced in that gas proved to be perfectly ductile, to be almost free from oxide inclusions, and to possess a high tensile strength.

The method of supplying an atmosphere of hydrogen around the arc is to direct a jet of hydrogen alongside the welding electrode, that is, the arc is drawn inside a hydrogen flame.

The first condition for drawing an iron welding arc in hydrogen is an open circuit voltage of the generator of at least 120 volts. The second characteristic is a high voltage drop across the arc, which for practical purposes is always about 40 volts. The sum of the anode and cathode drops in the welding arc of 100 amperes was found to be about 30 volts, which is more than double that of the same arc in air. This means that with the same welding current the apparent double resistance of the arc permits the liberation in the arc of double amounts of energy. By using arcs of 55 to

60 volts the energy of the arc is trebled and is sufficient to do welding of the stock up to half an inch in thickness without beveling the edges of the plate, thus saving much time and expense.

The average speed of welding obtained with the experimental apparatus on $\frac{1}{4}$ and $\frac{1}{2}$ -in. plates was considerably higher than that attained in air even with slightly higher currents. This high speed of the hydrogen weld is due to the greater arc energy and the welding without beveling the edges of the plate, which last factor reduces the amount of metal that must be deposited. The operation of joining two plates edge-wise is reduced to a rapid melting of the edges together and a compensation for the metal lost by electro-evaporation from the crater.

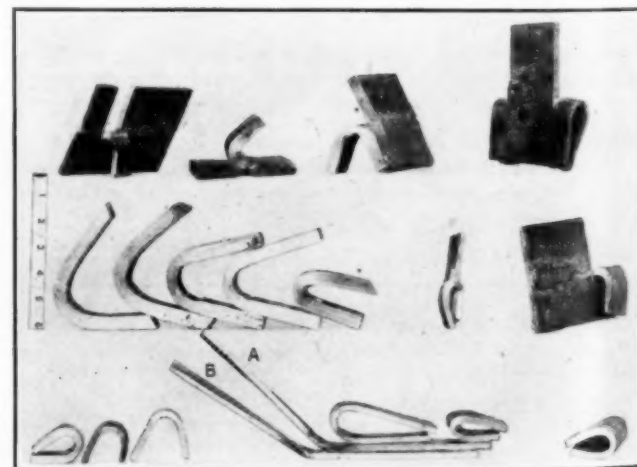
WELDS ARE DUCTILE

Tests on bars machined out of metal deposited entirely by the arc show an elastic limit from 39,000 to 42,600 lb. per sq.in., a tensile strength from 55,400 to 57,800 lb. per sq.in., reduction of area from 40 to 55 per cent and elongation from 29.5 to 36 per cent.

The remarkable ductility shown is a matter of prime importance for welds in structures subjected to vibration, accidental bending stress or overload. Also, it equalizes the internal cooling stresses when present in the weld.

If any part of the ductile weld is stressed beyond its elastic limit, it will not crack, but will yield until the stresses are more or less equalized all along the joint, which is so proportioned as to stand with safety the imposed load.

In making welds by this method the hydrogen acts not only as a blanketing medium but also as an energetic chemical reagent. Besides this action of molecular



Test Pieces Welded with Metallic Electrode in Hydrogen
Pieces A and B in the bottom row are test bars welded under identical conditions in air, but showing a maximum bend of 30 degrees

hydrogen a certain amount of the gas in the vicinity of the arc core is dissociated into the atomic state and its exceptional affinity for oxygen prevents any oxidation in the weld. Neither the oxygen produced by the decomposition of oxides present in the metal plate nor that which infiltrates through the hydrogen flame will combine with iron so long as a sufficient amount of hydrogen is present. The active nature of hydrogen is of paramount importance for practical application of the process, since it is impractical to devise a torch

that will absolutely exclude all the air from around the arc and unless hydrogen neutralizes the action of infiltrated oxygen and nitrogen the results cannot be uniform.

The continuous absorption and evolution of large amounts of hydrogen by the molten metal is equivalent to a thorough washing of the liquid metal with hot hydrogen. It is believed that the exceptionally high elastic limit of the deposited metal is due to this washing with atomic hydrogen. Indeed, the elastic limit of the pure iron electrode before deposition is on an average 29,000 lb. per sq.in., while the elastic limit of the same electrode metal, after being deposited by the arc in hydrogen, is about 42,000 lb. per sq.in.

ARC WELDING IN OTHER GASES

After the work on hydrogen had proved successful, gaseous mixtures containing hydrogen or substances which under the heat of the arc would produce hydrogen, were experimented with.

Water gas, used in the same manner as described for hydrogen, produced a weld that was perfectly ductile and that was easier to produce than welds made in an atmosphere of substantially pure hydrogen. It was found that the open circuit voltage of the welding generator need not be abnormally high and that the arc became much more stable.

Other investigations carried on with various mixtures in which the substantial composition of the resulting gases, when exposed to the heat of the arc, would be of the same nature as that of water gases, demonstrated that ductile welds can be produced in the atmosphere of any mixture of hydrogen and carbon monoxide.

Methanol, CH_3OH , of the synthetic variety, at temperatures of 700 deg. C., is completely decomposed into



Samples Twisted or Bent More Than 130 Degrees Without Cracking

The top row shows twisting tests, the middle row bending tests on pieces welded with carbon electrode in hydrogen and the bottom row bending tests on arc deposited metal

hydrogen and carbon monoxide. This permits the storage and easy transportation of a liquid that can be readily transformed into hydrogen and carbon monoxide. One gallon of methanol will give 232 cu.ft. of gas. Also, because methanol permits the storage of the CO in a chemically combined state, the danger of poisoning that might arise from a leaking gas container is avoided.

The decomposition of the methanol can be effected in a special dissociation chamber or inside of the flame

played from the nozzle of the welding torch. At the surface of the flame these gases combined with the oxygen of the air and, due to the excess of that gas, are completely converted into water vapor and CO_2 . It seems probable that, in the near future, welding in dissociated methanol will be almost as cheap as in water gas.

A series of experiments conducted with nitrogen-hydrogen mixtures demonstrated that mixtures of these gases give ductile welds and that the amount of hydrogen may be varied within wide limits. It may be as high as 90 per cent or as low as 10 per cent. If the proportion of either gas exceeds 90 per cent, the stability of the arc and the quality of the weld are characteristic of the predominating gas. By taking special precautions and by using gases of high purity, the



Thin Stock Specimens Welded in Hydrogen and Air

The pieces in the top row were welded with the metallic electrode, the center one in air and the next one part in air and part in hydrogen; bottom row, carbon electrode in hydrogen

percentage of hydrogen may be reduced to 6 per cent or even less and still produce fairly ductile welds. Yet for practical purposes when the welding is done under factory conditions, 8 per cent of hydrogen should be regarded as the lower limit. The presence of nitrogen in the mixture is manifested by a much lower striking voltage and a greater stability of the arc. The arc voltage also is greatly influenced and, as the experiments indicated, is directly proportional to the amount of hydrogen.

The possibility of using hydrogen-nitrogen mixtures enabled another solution of the problem of the storage of welding gases to be worked out. The only way in which hydrogen can be stored is by compressing it into cylinders, but compression as high as 2,000 lb. per sq.in. allows for the storage of only 200 cu.ft. of gas in a cylinder of the usual size. However, ammonia can be stored easily and can be dissociated into nitrogen and hydrogen, in the presence of a catalyst, at 600 deg. C.

The apparatus used for welding in dissociated ammonia consisted of an ordinary storage cylinder of anhydrous, liquefied ammonia and a dissociation chamber about 12 in. long provided with a catalyst and a heating coil. When ammonia has passed through this chamber it is entirely decomposed into a stable mixture of nitrogen and hydrogen and can be used immediately in the welding torch or stored in a gasometer. One 50-lb. capacity cylinder of ammonia will supply 2,250 cu.ft. of gas. At the present cost of ammonia, the gas mixture will cost about $\frac{1}{3}$ of a cent per cu.ft., compared to the cost of hydrogen sold in high pressure tanks at 1 cent per cu.ft.

Developing a Water Gas Process Using Bituminous Coal

Analysis of the phenomena occurring during gas generation resulted in the design of the pier process

By H. K. Seeley

Gas Engineer, United Gas Improvement Co.,
Philadelphia, Pa.

BITUMINOUS coal has always appeared to be a logical source of water gas fuel and a search through the engineering records of many gas companies will reveal that there has been an almost continual effort to devise some satisfactory means of utilizing this plentiful and relatively cheap fuel. Some of these efforts were partially successful and in some localities where this fuel is particularly cheap compared to the others available it has long been used to a considerable extent as a raw material for water gas manufacture.

The troubles encountered were, in all probability no greater in the past than they are today; but previous to the war there was, in most localities, considerably less difference in the delivered price of bituminous coal and the corresponding price of anthracite or coke, than now exists. The possible reduction in the final cost of gas was therefore much less than at present and the incentive to spend time and money in an effort to overcome the difficulties encountered, and realize this saving, was much less.

After the war conditions changed. Coke and anthracite prices reached almost prohibitive levels and for a while it looked as if the production of gas by the water gas process would soon be a thing of the past. The price of bituminous coal also went up but the differential in the cost of the two types of fuel, delivered in the gas works yard, increased greatly in favor of the bituminous coal. Increased freight rates played an important part in this. Gas companies again directed their efforts towards devising means of utilizing this fuel. The changed conditions, even with the inefficient methods then used, made the process sufficiently attractive from the financial point of view for nearly every one to experiment with it.

OBJECTIONS TO BITUMINOUS COAL

There were from the beginning three principle objections to the use of bituminous coal in the generator. The first and probably the most important was the reduction in gas-making capacity. Small machines suffered less in this respect than the larger ones, but the loss of capacity for all sizes was considerable, amounting to 50 per cent in the larger ones. The second objection, also a very serious one in many situations, was the smoke emitted during the blasting period. And finally, applying entirely to carburetted water gas plants, was the serious reduction in the oil efficiencies due to the high temperatures produced in the carburetter and superheater.

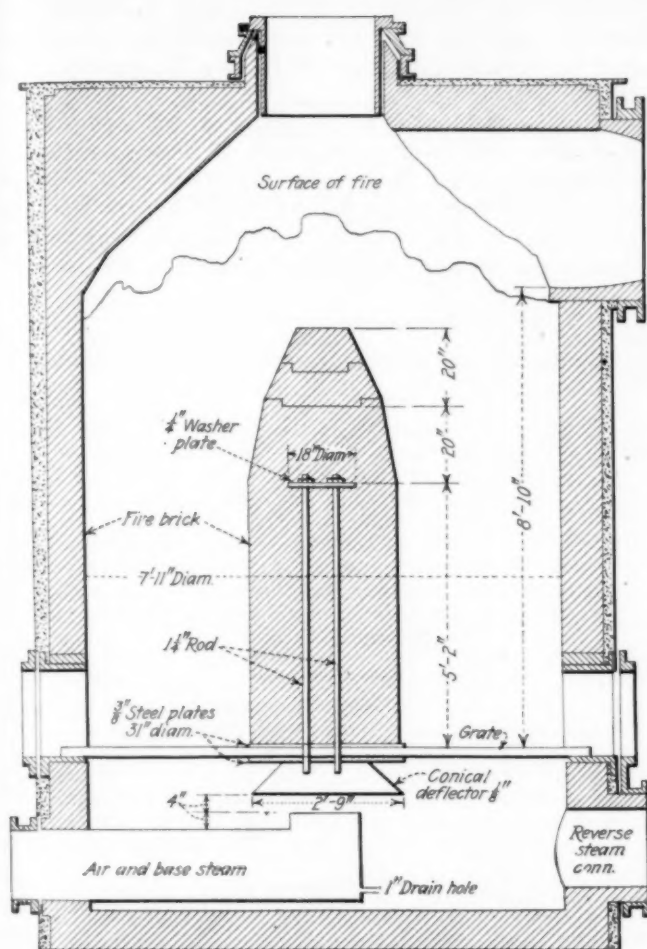
The development of the "Blow-run" gas-making cycle was a big step in meeting these objections. Smoke was partially eliminated, the capacity was increased, and

better control of the temperatures in the carburetter and superheater was obtained. There still remained one very serious difficulty and one that practically prevented the use of 100 per cent bituminous fuel. This was the tendency of "blow holes" to form in the fuel bed. On large machines such a blow hole will frequently form on the second or third run after coaling up and once it forms, it is necessary to shut down and fill it up by barring the fire from above. Very little gas will be made and that of very poor quality as long as the blow hole exists. Furthermore a large quantity of fuel will be carried over in the chambers and connections beyond the generator. So serious were the blow hole troubles, that except for plants equipped with small diameter generators, very few were able to use bituminous coal alone.

UNCARBONIZED CONE OF FUEL FORMS IN GENERATOR

It was early discovered that the cause of these blow holes was the formation of a central inverted cone of uncarbonized fuel. This cone forms shortly after starting up the machine after cleaning and due to its compact nature, little or no air and steam passes through it. Since neither air nor steam comes in direct contact with the fuel in this cone neither carbonization nor combustion takes place and the cone once formed remains until broken up by barring. Even this disagreeable, if not dangerous, method is only partially successful in breaking up the cone which immediately forms again.

It was at first believed that this cone was caused entirely by the nonhomogeneous character of the fuel bed, formed by the usual method of charging through a centrally located coaling door in the top of the generator. It is a fact that charging in this manner is nearly an ideal method of separating the larger sized lumps from the smaller ones. As the coal falls into the generator the larger lumps go to the sides while the fines and smaller lumps remain in the center. The larger the lumps in a mass of fuel, the greater the spaces between them, and the more easily air and steam can pass up through. Thus at the very start there is a tendency for most of both the air and steam to pass up through the outside of the fuel bed. The result is that the three processes by which the fuel is used up, viz., combustion, decomposition and distillation, all take place much more rapidly at the outside of the fuel bed than nearer the center. Thus the quantity of fuel and hence, the thickness of the fuel bed, decreases more rapidly at the outside than in the center and the condition, bad enough at the start, becomes rapidly worse until so large a portion of the



Layout of Pier Used in Water Gas Generator at
Des Moines, Iowa

This shows the solid type of pier finally adopted after trying out various forms of hollow piers which permitted central introduction of air and steam

air is coming up the sides that it breaks through the bed producing a blow hole and carrying the fuel out of the generator.

It was first thought that this could be overcome by keeping the fuel bed higher at the sides than in the center and numerous means were devised for doing this but none were more than partially successful. It was found however that if part of the fuel used was either coke or anthracite coal and if these latter fuels were charged first and directly into the center, while the bituminous coal was spread to the sides as much as possible, most of the troubles were eliminated.

There are today a large number of plants successfully operating with mixtures of bituminous coal and either coke or anthracite. The percentage of coke or anthracite required varies with the size of the generator from 20 per cent in the smaller sizes to 50 per cent or more in the larger. There are only two objections to this method but both are serious. First, the possible saving in cost of gas due to the use of a cheaper fuel is reduced in direct proportion to the percentage of the higher priced fuel used. Second, it is necessary to handle two kinds of fuel which increases the cost of fuel handling and general works operation. It was found after a considerable study of the subject had been made, that the success of the mixed fuel process is not entirely due to keeping the fuel bed open by charging the center of the generator with hard fuel although this is the primary reason for the success of the mixed fuel process.

The more direct reason lies in the fact that the presence of the hard fuel reduces the quantity of bituminous coal that must first be carbonized before water or blue gas can be made, and also that the combustion of this hard fuel during the blasting period furnished the necessary heat to distill or carbonize what bituminous coal there is present in the center of the fuel bed. Thus no central cone of unburned and uncarbonized fuel forms in the fire and the entire fuel bed is active for gas making purposes.

It seems strange that while the formation of this inactive cone immediately suggested to nearly every one the installation of some form of structure designed to decrease the resistance to the flow of steam and air through the central sections of the fuel bed, it required a long series of experiments and the expenditure of much time and money to discover that the best device was a solid pier in some form or other. This was undoubtedly due to the failure of the experimenters to realize the true reason for the formation of this inactive cone.

WHY SMALL GENERATORS WERE SUCCESSFUL

All experience so far tends to show that there cannot be stored up during the blasting period, in a fuel bed consisting of bituminous coal, sufficient heat to produce the decomposition of steam during the run and at the same time allow the carbonization of the coal to continue. The reason why the fuel bed adjacent to the side walls of the generator appears to be able to do this, is because the side walls themselves becoming highly heated during the blasting period radiate into the fuel bed large quantities of heat during the "run" or gas making period. Experiments have indicated that the radiations from the walls will penetrate approximately eighteen inches into the fuel bed and if the two walls are not more than approximately thirty-six inches apart there is no tendency for an inactive zone to form. This explains why plants having generators the internal diameter of which is little if any greater than three feet, were able to use one hundred per cent bituminous fuel with fair success without changes to the machine while larger generators could not be used in this way.

WHAT THE PIER ACCOMPLISHES

The necessity for this radiant heat is further indicated by some of the early experience with piers. The first ones tried were made hollow and openings provided to allow air and steam to enter the center of the fuel bed. That this scheme did not produce satisfactory results tends to prove that the failure of the air and steam to penetrate the center of the fuel bed was not the sole cause for the formation of the inactive zone. The cooling effect of these gases passing through the pier reduced the temperature of the pier walls below the point where they radiated sufficient heat to accomplish the necessary carbonization of the fuel. Blow holes formed at the center of the fire and excessive combustion took place during the blasting period, increasing the fuel used per M of gas made.

The introduction of the solid pier has successfully overcome nearly every objection to the use of bituminous coal. It has in effect reduced the horizontal width of the fuel bed to the point where the radiation from one side or the other is effective to all parts of the bed. Hence complete carbonization can take place and the coke residue can then be converted into water gas. It

is just as impossible, and for the same reason, to make blue water gas from bituminous coal without first distilling off the volatile matter as it is to make steam from ice without first melting it.

The pier serves another very useful purpose in that it becomes merely another side wall. The percentage of voids is always greater immediately adjacent to the side wall than in the middle of a pile. This fact permits the easier passage of air and steam at this point and results in the rapid use of fuel near the center of the fire. At the same time this reduces the quantity of both air and steam passing through the outer zones of the fuel bed and results in keeping a more even thickness of bed, almost eliminating the formation of blow holes.

The pier process was developed in the Joliet, Ill., plant of the Coal Products Mfg. Co. under the direction of W. J. Murdock, superintendent of that company, assisted by members of his organization and engineers of the U. G. I. Contracting Co. of Philadelphia. After many partially successful attempts to utilize piers of various sizes and shapes, some solid and some hollow with perforated side walls to allow air and steam to enter the center of the fuel bed, the present designs, similar to that shown in the accompanying figure, were found to be the most suitable.

These designs which have long since passed the experimental stage and are in successful operation in a number of gas plants, have been placed on the market by the U. G. I. Contracting Co. and thus made available to industry as a whole.

The pier process should appeal more particularly to the manufacturer of blue gas than to any one else in the gas business, for the reason that with it he can make a high quality of blue gas using bituminous fuel and at the same time approach the capacity obtainable with coke or anthracite. This can be accomplished with no increase in the generator fuel per M and in this industry the cost of the generator fuel represents nearly the entire cost of the raw material. Both in actual dollars and cents and in percentage of total cost, the savings will be greater per M of gas made than will be the corresponding savings of the carburetted water gas manufacturer.

SOME EXAMPLES OF SAVINGS BY THE PIER PROCESS

Just what these savings mean may be shown by the following actual figures from one plant, in this case manufacturing carburetted water gas. The machines equipped with a Chrisman cycle used approximately 28 lb. of coke per M; the generator fuel cost per M amounted to 16.8c. per M. They were unable to successfully use more than 50 per cent bituminous coal before the installation of the pier process. With this mixture it was possible to get fair capacity. The fuel per M averaged about 35 lb. but this was before the Chrisman cycle was installed. It is estimated that this installation reduced the fuel required by 3 lb. per M so that it may be safely assumed that they would have been able to operate on about 32 lb. had the machine been so equipped at that time. The price of the coke was the same, viz., \$12.00 per net ton delivered in the bins. The rather low grade bituminous coal is purchased at a price of \$6.33 per net ton delivered.

With 50 per cent of each fuel and 32 lb. per M the cost per M of gas, for generator fuel only, figures out at approximately 14.66c. per M.

After the installation of the pier the plant was actually operated with 100 per cent of the bituminous fuel on slightly less than 32 lb. per M; equivalent to 10.13c. per M.

Thus by the use of bituminous coal without the pier they were able to effect a saving of 2.14c. per M. By installing the pier they were able to save 6.67c. per M or 4.53c. per M which can be attributed to the pier. This plant makes about 1,000,000 M per year so that this saving amounts to approximately \$45,300 per year.

ADVANTAGES OF THE PROCESS

The advantages of a pier process may be summed up as follows:

1. It makes possible the use of 100 per cent bituminous coal for generator fuel particularly in water gas machines of the larger sizes. Without a pier it is practically impossible to do this efficiently.

2. Capacities comparable to those obtained by the use of good coke or anthracite fuel can be obtained. Without a pier in the larger sizes of machines the capacity is reduced 50 per cent or more unless it is increased at the expense of quality of the gas produced. With a pier 90 per cent the regular capacity can be obtained.

3. The efficiency of operation is made equal to or even better than for anthracite or coke. The fuel used per M of gas made is very largely a question of the quality of the fuel, but with a good grade of bituminous fuel as low a figure in pounds per M can be expected as when a correspondingly good grade of coke is used. Without a pier from 3 to 6 lb. more fuel will be used than with a pier. This statement applies for bituminous fuel only.

4. The pier may be installed in any generator and may be used with any of the various processes now in use.

The pier process obtained its name because the first successful attempt to apply the principles of the process was made with a centrally located, solid column or pier. Several modifications of this idea have been worked out, the most successful of which other than columns mentioned just above, is the so-called "cross wall."

CROSS WALL PROCESS IS MODIFIED PIER PROCESS

The chief claim to distinction possessed by the cross wall is that it can be used in generators too small for the practical use of the solid pier. Purely mechanical difficulties prevent the use of a pier in sets smaller than 9 ft. external diameter. Tests have shown that such a pier will work as satisfactorily in a small generator as in a larger one, but of course the dimensions of the pier must be reduced to correspond to the smaller inside diameter of the generator. When this is done the pier becomes unstable and it is difficult to prevent it from tipping over.

The cross wall has a further advantage over the pier in that it does not decrease the grate area as does the pier. Whether this will make an appreciable difference in capacity or efficiency in the larger machines remains to be seen. Such cross walls as are now in use have been installed in sets of 9 ft. outside diameter or less so comparative figures are not available. They are however being installed in larger generators at the present time.

When the mechanical generator comes to its own, as it undoubtedly will in the near future, the cross wall will possess a great advantage over the pier. The cross wall is however simply a slightly different application of the same principles involved in the use of a pier.

Correction of Radio Interference From Cottrell Precipitators

Investigation made by the Western Precipitation Company and the Research Corporations develops successful correctors

By J. J. Jakosky

Member, Institute of Radio Engineers

IN THE OPERATION of Cottrell electrical precipitator installations and similar apparatus where high potentials are used, electromagnetic radiation sometimes occurs which causes local interference with radio reception. Considerable research work, with a view to eliminating the interference, has been done during the past few years by various precipitator plants and wherever serious radio interference has been caused, means have been devised for entirely eliminating or greatly minimizing the interference to radio reception. The problem has been solved by different methods at the various plants, and in some cases the solution has been quite expensive. However, no simple, universally applicable solution of the problem had been found so it was decided to make a more fundamental study of the general problem of radio interference and methods for its prevention for Cottrell precipitator installations, and other types of high and low voltage equipment. This investigation was undertaken jointly by the two companies who have developed the art of electrical precipitation in America: the Western Precipitation Company and the Research Corporation.

As the result of this work a standard set of interference correction equipment has been developed which may be installed in any precipitator installation for the complete stopping of all radio interference, without changing the electrical characteristics of the circuit or interfering with the proper operation of the precipitators.

In practically any type of electrical circuit where the current flows in a pulsating or non-continuous manner with a steep wave front, high frequency line transients may be generated. Such high frequency currents flowing in the circuit may be radiated as electromagnetic waves. Such waves will cause interference in radio reception—the extent of which depends upon the magnitude of the high frequency currents and the facility with which these currents may be radiated into space or carried as line radio by power, lighting and telegraph lines to radio receivers. The interference caused by line radio is confined largely to receiving apparatus located in close proximity to such circuits which may extend many miles from the seat of the interference.

In many power circuits the voltage wave consists not only of a definite fundamental combined with its higher harmonics, but also contains currents of irregular pulses of varied frequencies. The combination of a fundamental with a series of higher frequency currents of irregular values may produce a very complex wave form. The relative values of resistance, inductance, and capacity determine to a large extent the resultant current wave.

In a circuit containing resistance only, the higher frequencies receive the same relative attenuation as the fundamental. In circuits where both resistance and inductance predominate, the higher harmonics suffer greater attenuation since the inductive reactance increases with the frequency. The current wave, is, therefore, less peaked.

In circuits where resistance and condensance predominate, the effect is just the reverse, since an increase in the frequency results in a reduction of the capacitive reactance and resultant impedance with a proportionate increase in current flow. As a result, the original current wave suffers greater attenuation than the higher frequency currents and the resultant current wave is highly distorted and peaked.

Due to the sparking and interrupted current flow in the gaps of the mechanical rectifier and in the precipitators themselves, many frequencies are present other than the initial 60-cycle rectified wave. These frequencies probably range from the lower harmonics of the 60-cycle current to the very high frequencies caused by the oscillatory nature of the spark discharge across the rectifier terminals and "snapping" within the precipitators.

The current flow or pulse in the precipitator circuit is not of the "square" or simple type wherein the voltage rises suddenly, holds this value for a given period of time, and then suddenly drops. The effect of such a pulse can often be calculated, knowing the constants of the circuit. The actual precipitator current consists of a series of regular impulses, superimposed on which are high frequency, irregularly timed impulses caused by the sparking at the rectifier contacts and the leakage ("snapping") in the precipitator tubes. The effects of transient currents superimposed on a current of regular period may be seen from Fig. 1. In curve "A" is a hypothetical double-wave rectified current, with the lower portion of the wave cut-off by the mechanical rectifier. In curve "B" is shown a higher frequency surge as assumed to be present in an oscillatory path of the precipitator circuit. The resultant e.m.f. of these two waves is shown in curve "C." It will be noted that the resultant wave has lost its original form and is highly distorted and peaked. The wave also has lost its unidirectional properties and fluctuates on each side of the zero line. Currents of this type, having characteristic beats, produce "frying," "buzzing" or "hissing" when received by radio sets. Under proper circuit conditions the oscillatory current will exist in a series of trains or groups of the same frequency as the primary pulse; i.e., a radio-frequency current which is modulated at the frequency of the rectifier interruptions. The radiated wave of such current, when

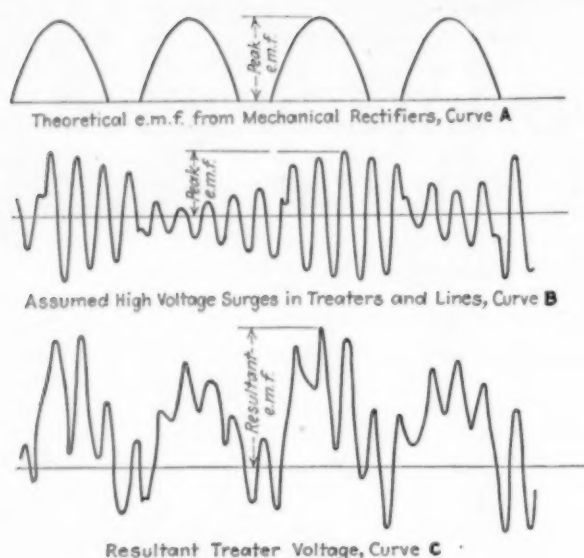


Fig. 1—Curves Showing the Effect of Transient Currents Superimposed on a Current of Regular Period

picked up by a radio set, gives a sound with the frequency of that of the pulse. A 60-cycle pulse would, therefore, produce a 60-cycle hissing or buzzing sound in the radio set. For this reason it is often difficult to distinguish between Cottrell and some types of power line interferences.

ELECTRICAL CHARACTERISTICS OF PRECIPITATOR CIRCUITS

A schematic wiring diagram of a simple precipitator circuit is shown in Fig. 2. The apparatus consists essentially of a high voltage step-up closed-core power transformer; a synchronous double wave spark-gap rectifier; the necessary connecting line, insulators and bushings between the high voltage apparatus and the precipitators; and the precipitator equipment—consisting of fine wire-electrodes suspended between plates or axially within pipes or tubes, through which the gas to be treated is passed.

For continuous or low frequency currents the schematic diagram represents the circuit sufficiently well. However, due to the electrical characteristics of a Cottrell installation, a more detailed circuit diagram is necessary for a complete understanding and explanation of the phenomena involved. The effects of small circuit capacities and inductances are negligible in dealing with continuous current or low frequency alternating current, but must be considered when high frequencies are involved. As previously stated, the current delivered by the synchronous rectifier is not a simple rectified alternating current, but contains in addition to the 60-cycle component, typical surging and transient currents.

Under such conditions an equivalent precipitator circuit with its various distributed, as well as lumped capacities and inductances, would be represented somewhat as in Fig. 3. Various capacities, due to bushings, windings, etc., exist at the transformer. The synchronous rectifier may be represented as a double spark gap between which exists a capacity due to transformer bushings, case, coils, etc. The high tension line connecting the rectifier and the precipitators contains small values of inductance and various capacities to ground. The precipitators may each be represented as a capacity shunted by a resistance, due to the current leakage caused by the ionized gas. An equivalent precipitator

circuit will therefore be recognized as a plurality of parallel oscillatory circuits the constants of which may vary in each part of the installation. It should be noted that very little of the transformer inductance is actually in the oscillatory circuit, due to the many capacities which readily by-pass the higher frequencies. The circuit, therefore, is not a simple series circuit containing lumped inductance, capacity and resistance, but these effects are distributed at various points. Such a circuit will not obey the relationship expressed by formulas which govern simple series circuits containing lumped values of inductance, capacity and resistance and calculations based on such formulas will lead to false conclusions.

The radio interference from an oscillatory circuit may be stopped by one of four general ways: (1) Shifting of the frequency to a higher or lower value where no local commercial, amateur or broadcast interference will be noted; (2) lowering the frequency to a value where the radiated current will be negligible—the radiated current varying directly with the second or higher power of the frequency; (3) completely stopping all radiation by preventing high frequency currents in the circuit; and (4) complete shielding of all conductors and coupled circuits carrying high frequency currents.

Shifting of the frequency in order not to interfere with local reception is only a partial solution to the problem, and one which cannot be applied generally to all radio interference problems, since various frequencies are of importance in different locations due to proximity of radio stations of various uses.

Shifting of the frequency to a very low value where negligible radiation takes place offers possibilities in preventing radio interference.

The complete suppression of all radiation by stopping high frequency oscillations is an absolute solution to the problem as regards radio interference. Complete suppression of oscillations or the shifting of frequency both offer advantages and disadvantages as regards treater operation. Which of these two can best be adapted will depend largely upon its effect on precipitator operation and other economic considerations.

Complete shielding of all high voltage lines is not considered a practical solution to the problem for two major reasons: (a) High installation cost and voltage insulation difficulties and (b) line-radio interference caused by feed-back into power circuits through transformer or equipment capacities or by induction which it is very difficult to prevent.

EFFECTS OF RESISTANCE IN PRECIPITATOR CIRCUITS

One of the easiest ways of stopping oscillation in a circuit is by adding resistance. For a simple series circuit, the resistance required to prevent oscillations may be calculated, knowing the constants of the circuit. The natural frequency of any simple series circuit may be expressed by the general formula:

$$f = \frac{1}{2\pi\sqrt{LC - \frac{R^2}{4L^2}}}$$

where L is inductance
 C is capacity
 R is resistance
 f is frequency

In cases where $\frac{R^2}{4L^2}$ is equal to or greater than $\frac{1}{LC}$ the free oscillations in the circuit are impossible. Such a circuit is said to be "aperiodic"—it will not allow free

oscillations and has no free period of its own. Mathematically this condition may be expressed as follows:

$$\begin{aligned} \frac{R^2}{4L^2} &> \frac{1}{LC} \\ R^2 &= \frac{4L^2}{LC} = \frac{4L}{C} \\ R &> 2\sqrt{\frac{L}{C}} = \text{condition for non-oscillatory circuit.} \end{aligned}$$

Therefore, when the resistance of a simple series circuit is equal to, or greater than, twice the square root of L/C the circuit will not oscillate. This elementary formula, given by many writers, can not be applied directly to practical interference problems of a complex nature.

The effective resistance of a conductor varies with the frequency. In an oscillatory circuit the following factors determine the effective resistance: (1) Ohmic resistance of the conductor itself; (2) skin effect and diameter of conductor; (3) resistance of neighboring closed circuits and their proximity; (4) permeability of magnetic material near conductors carrying high frequencies; (5) dielectric and hysteresis losses; (6) corona losses; (7) radiated energy, which causes the radio interference. The combined magnitude and effects of the above govern largely the oscillatory currents flowing in a circuit of given values of inductance and capacity.

The ohmic or direct current resistance of the precipitator circuit is usually relatively low. The skin effect on such conductors may greatly increase the high frequency resistance—depending upon the general distribution of current in the conductor (dependent upon nearby conductors and diameter). The resistance of neighboring closed circuits is of considerable importance. If the high tension lines supplying the precipitators are closely coupled to closed circuits (such as closed railings, wire nettings, etc.) the effective resistance will be increased. Dielectric losses may be quite high, mainly occurring in the precipitators where considerable insulation is used to support the high tension discharge member assembly.

For good conductors, the continuous current resistance is usually lower than the high frequency resistance due to re-distribution of current because of the skin effect. The writer has, however, observed cases where the high frequency resistance of certain types of resistors was considerably lower than the continuous current resistance. Especially is this true of those resistors depending upon "point contact." The capacity and "point" effects of the particles in the resistor often lower the effective resistance. The failure of resistances to completely stop radio interference is, however, probably due as much as the complex nature of the precipitator circuit as to the low effective resistance of some types of resistor rods.

While it should be possible therefore to entirely stop oscillations in a precipitator circuit by the use of high

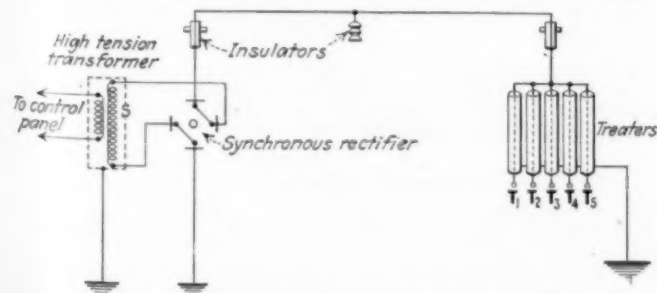


Fig. 2—General Diagram of Connections for Precipitator Circuits

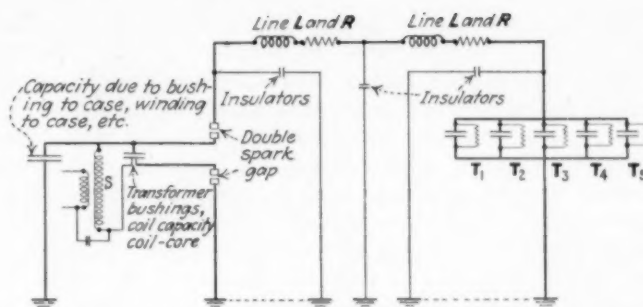


Fig. 3—Equivalent Precipitator Circuits, Showing Its Various Distributed as well as Lumped Capacities and Inductance

frequency resistors in various parts of the circuit, the design of a simple and practical type of resistor suitable for field and plant operation offers difficulties. The power losses incidental to the use of such resistances are not conducive to the most efficient operation, as regards electrical efficiency.

In any given installation, the addition of capacity will be favorable for an increase in magnitude of the transients. Capacity need not be added in the well known form of high voltage condensers, but may be added unintentionally by connecting additional treaters to the circuit, or by additional line or insulation capacities. Increasing the capacity of a treater installation may often decrease the frequency (increase wave length) due to the higher oscillation constant. The increase, however, will not be as great as would be predicted by simple series circuit formulas, due to the complex nature of the equivalent treater circuit. The addition of treater units to an installation with a given electrical equipment is a special case whereby additional capacity is added to the system, at the same time decreasing the circuit resistance. For any given installation the addition of precipitators will be favorable for an increase in magnitude of the radio-frequency currents. This may be predicted mathematically by the previously given general oscillatory series circuit formula.

The amplitude of the oscillations increases with a decrease of R and with an increase in C . If each precipitator is considered as equivalent to a capacity shunted by a resistance, then the greater the number of treaters in parallel in the circuit, the greater the total circuit capacity, C , and the lower the resistance, R .

EFFECTS OF INTERNAL COIL CAPACITY

The addition of inductances to a simple series circuit, produces results similar to the addition of capacity previously mentioned. The equivalent circuit resistance is increased, however, due to the high frequency resistance of any inductance coil. The effects of added capacity or inductance must be considered not only as regards radio interference but also in connection with the operation of the precipitators. The promiscuous insertion of inductance in a precipitator circuit is liable to interfere with the proper operation of the treaters and also cause excessive arcing or burning at the rectifier.

A "choke" coil, for use in suppressing radio frequency currents, must in addition to the desired inductance, have a low distributed capacity in order to offer a high reactance to radio frequency currents. The internal capacity of the coil varies with the type of construction. The relative values of distributed capacities for various types of coils is illustrated in Fig. 4. In this figure the capacity between adjacent

turns is represented by the imaginary condenser C_a . This capacity is the same, of course, for any type of winding where each turn is wound adjacent to the next. In the case of a multi-layer coil, as shown at A and B, Fig. 4, the capacity between layers varies with the type of winding. The "honeycomb," "bank" wound or similar type of windings have a lower capacity, C_p , between layers than the ordinary multi-layer coils. Due to the capacities C_p , the terminal capacity C_T is greater for the multi-layer coil than for the honeycomb type of winding. Multi-layer coils usually have a fairly high internal capacity which may be of sufficient value to offer relatively low capacitive impedance to the high frequencies. Especially is this true of many of the so-called "low distributed capacity" coils. Such coils are quite compact, often with high capacity between ends of the winding. The single layer solenoid type of winding, shown at C, actually has the lowest distributed capacity and is, therefore, the best suited for use as a radio frequency choke.

The iron-core choke coil offers advantages, if properly designed, for use in precipitator circuits. The use of iron increases the effective resistance of the coil which is advantageous in absorbing the high frequencies. Iron core chokes have been tried for suppressing transients in treater circuits, but numerous investigators have reported negative results.

What information is available, however, of previous investigations indicates that insufficient attention was paid to the design of the choke for the higher frequencies. In D, Fig. 4, is shown an equivalent choke and continuous iron-core circuit. It will be noted that considerable capacity exists between the winding and the core. Especially is this true when the core is merely wrapped with a heavy layer of insulating material, over which is wound the wire. The capacity C_c between core and winding, allows the high frequency currents to travel from the first few turns of winding to the core, thence through the iron core to the other end of the coil. The iron and the core-to-winding-capacity, therefore, serve as a by-pass for the high frequencies. In order to overcome this and at the same time allow the use of iron, a special type of sectional core may be used. The core is built in short sections—each section insulated from the other. As a result, the high frequency currents leaking to the first section of the core are prevented from by-passing the coil, due to the low capacities existing between core sections. This is illustrated in E in Fig. 4. The German precipitator company, the Metallbank und Metallurgische Gesellschaft, affiliated with the Western Precipitation Company, has adopted a continuous iron core coil, with the core connected to ground. Such a design is satisfactory as regards stopping of high frequency transients but requires insulation between core and winding of a value sufficient to withstand full precipitator voltage, which in various installations ranges from 20,000 to 100,000 volts.

REFLECTION PHENOMENA AND RADIO FREQUENCY POTENTIALS

The use of chokes to prevent the passing of transients and high frequency currents often causes high voltages to build up ahead of the choke, due to reflection phenomena and the high reactance of the choke. This potential may be of considerable magnitude, depending upon the frequency and the electrical characteristics of the circuits. Such potentials superimposed

on the low frequency voltages of the precipitator circuit may cause disruptive peak voltages. This is of particular importance in connection with proper operation of the mechanical rectifier. For certain parts of the circuit, the choke must, therefore, not only prevent such high frequencies from proceeding further in the circuit, but should also absorb or dissipate the high frequency energy. In addition, the choke should contain a minimum of effective inductance and a maximum of effective resistance. Such a choke, called an absorber coil, was developed in the course of the experimental investigation.

The e.m.f. developed due to the impedance of the chokes, when inserted in the circuit, varies with the inductance, wave length, or frequency of the transients, and the characteristics of the precipitator circuit. The highest potential is usually obtained across the terminals of the chokes placed in series with the transformer. Potentials higher than 100,000 volts have been measured. The potential across the ground line choke is usually of a lower value and about 10,000 volts. The potential across the chokes in the precipitator high tension circuit varies from 5,000 to 15,000 volts, depending upon conditions, number of chokes, etc.

The potential developed across the choke coils placed in series with the transformer secondary leads, vary with the capacity in the circuit. As previously mentioned, the capacity across the secondary winding of the transformer is composed of the coil-to-core capacity, insulator capacities to case and across terminals, etc.

Where ordinary porcelain or Bakelite lead-in-bushings are employed for the high tension terminals the total capacity in the secondary circuit is seldom of a value to cause higher potentials than 20,000 volts to be developed across the chokes. When transformers employing the "condenser-type" bushing are used, the additional capacity added to the circuit causes higher potentials to be developed across the coils. With this type of lead-in bushing, potentials of over 100,000 volts are often developed. In order to take care of these higher potentials and prevent break-down or leakage, it is necessary to insert an additional choke in series with the secondary chokes.

The theory governing the design of the absorber type coil depends upon the change in effective resistance of two inductively coupled transformer circuits.

Designating the primary resistance and inductance as R_1 and L_1 respectively; and the resistance and inductance of the single turn ring or secondary as R_2 and L_2 (the use of more than one ring in parallel in the secondary circuit results in closer coupling, lower effective secondary resistance, higher flux density, and greater radiating surfaces for dissipating the secondary power), the theoretical voltage induced in the secondary circuit is:

$$E_2 = 2\pi f \times M I_1 \text{ or } 2\pi f M$$

The current in the secondary is therefore:

$$I_2 = \frac{E_2}{Z_2} = \frac{2\pi f M}{Z_2}$$

Due to phase relations between primary and secondary currents and the coupling, it can be shown that the effective resistance of the primary is:

$$R_{\text{Effective}} = R_1 + \left(\frac{2\pi f M}{Z_2} \right)^2 \times R_2$$

The mutual induction between the two circuits may be expressed as:

$$M = K \sqrt{L_1 L_2} \text{ in which}$$

K = Coefficient of coupling—near unity

for well designed closed core transformers at low frequencies, but considerably less for high frequencies and air core transformers.

L_1 = Total self induction of the primary circuit.

L_2 = Total self induction of the secondary circuit.

Z = Impedance.

The effective resistance therefore may be expressed as

$$R^1 = R_1 + \left(\frac{2\pi f K \sqrt{L_1 L_2}}{Z_2} \right)^2 \times R_2$$

From these relationships, it may be seen that the high frequency effective resistance of the absorber coil may be many thousands of ohms, while the low frequency resistance for the rectified pulsating current is only a few ohms greater than the resistance of the primary winding itself.

In any coupled circuit the effective inductance of the primary is always changed by presence of the secondary. The inductance may be expressed by a relationship similar to that given for resistance, and is:

$$L^1 = L_1 - \left(\frac{wM}{Z_2} \right)^2 \times L_2$$

$$= L_1 - \left(\frac{2\pi f K \sqrt{L_1 L_2}}{Z_2} \right)^2 L_2 = L_1 - \left[f^2 \left(\frac{2\pi K \sqrt{L_1 L_2}}{Z_2} \right)^2 \right] L_2$$

From which it may be seen that the effective inductance of the primary is decreased by the current flowing in the secondary circuit. Considering the relationships existing between effective resistance and inductance in coupled circuits of this type, it is seen that the effect of the current flowing in the secondary is to increase the resistance of the primary circuit by the amount:

$$f^2 \left(\frac{2\pi K \sqrt{L_1 L_2}}{Z_2} \right)^2 \times R_2$$

and to decrease its self induction by the amount,

$$f^2 \left(\frac{2\pi K \sqrt{L_1 L_2}}{Z_2} \right)^2 \times L_2$$

It should also be noted that these effects vary directly theoretically with the square of the frequency. This, of course, is not strictly true in practice, due to current redistribution and skin effect, capacity effects, magnetic losses, decreased permeability of iron, etc., at high frequencies. The combined effects may be summarized by stating that the low frequencies suffer only slightly from the small change in effective resistance, while for the higher frequencies the effective resistance is greatly increased and the self inductance is greatly decreased. The increase in resistance and decrease in inductance thereby tend to inhibit oscillation. The design of the absorber coils is such that when used in conjunction with the choke coils, the electrical characteristics of the treater circuit will not be changed sufficiently to cause a decrease in operating efficiency of the treaters.

In the early forms of iron core coils, the iron was placed within the winding in accordance with usual practice. This necessitated rather bulky construction in order to take care of the heat generated by eddy and hysteresis losses in the iron. In the later design the iron is placed outside of the winding, and while not as efficient from all theoretical viewpoints, is better in commercial practice as the heat may be readily radiated and construction simplified. The iron is also slotted to prevent the decrease in apparent permeability at the higher frequencies.

Various types of choke coils, absorbers, resistances, condensers, etc., were used during the investigations. In order to save space, description of this equipment will not be given. Description is included, however, of the final equipment which is being used for the cor-

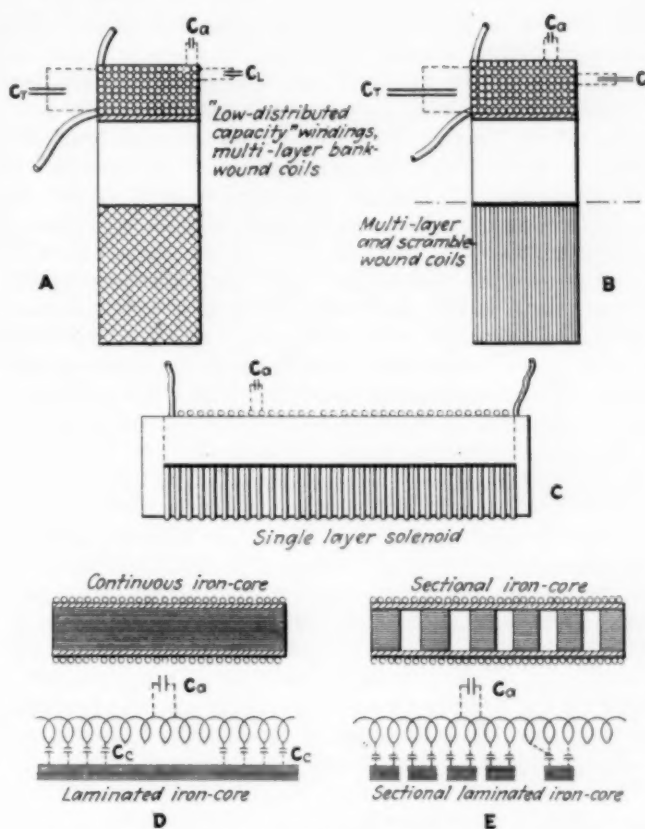


Fig. 4—Various Types of Choke Coils, Illustrating Their Internal Capacity

rection of radio interference in commercial installations.

Numerous field and laboratory tests were conducted to determine the most effective design for an absorber coil. The primary winding consists of a single layer coil, wound on a Bakelite tube, over which are placed one-turn iron secondary coils. The design of the secondary coils (taking into account permeability and resistance of the iron) is such as to give low capacity effects, increased flux density, and high losses to the transient currents, consistent with fairly close coupling.

The effective resistance of the absorber coil varies with some power (approximately the square) of the frequency. The higher transients therefore suffer much greater attenuation than the low frequency pulsating rectified current. As a result, the losses for the rectified current are reduced to minimum, while the losses for the undesirable high frequency transients are great. Only one of the absorber coils is required in the average precipitator installation.

The high tension line connecting the rectifier and the precipitator is one of the main radiating parts of the installation. In the tests on the laboratory installation, it was found that even when chokes were inserted at each of the four rectifier terminals and at the treater some radiation was still taking place at 130 and 170 m. Inserting a choke in the center of the line eliminated the 170-m. band. In the test at one operating plant, it was found that an interference band was being radiated at 180 m. The insertion of chokes at the treaters and rectifier terminals, did not help matters, so the high tension line connecting treater and rectifier was lowered and a strain type choke inserted in the center of the line. This entirely removed the interference. Tests indicate that the high tension line connecting the treaters and rectifier oscillates as a free wire when isolated from the rest of the system by suitable chokes

and that it is necessary to insert chokes in any line which is longer than 50 to 75 ft.

It must not be thought that the high tension lines themselves are the only radiating members. In some installations it was found that long ground lines, especially in arid regions, are sources of radiations. It is also interesting to note that some portions of the high tension circuit oscillate and radiate, while other portions do not. This is due to the many parallel capacitive paths which exist between high tension line and ground. Every supporting insulator, switch, mountings, etc., acts as a condenser. The capacity to ground of the large pole-operated knife switches, such as are used for connecting to auxiliary lines, etc., is quite high, depending upon type of insulation, mountings, etc.

The choice type correctors consist of a single layer wound inductance. The reactance offered by an inductance to the flow of alternating current varies directly as the frequency. This may be expressed as follows: $X = 2\pi fL$, in which X is the reactance, f the frequency, and L the inductance. From this equation it will be seen that the reactance offered by a coil to low frequency, say the 60-cycle pulsating precipitator current is only a minute fraction of the reactance offered to the high frequency radio currents, having frequencies in the neighborhood of 500,000 to 1,500,000 cycles per second.

Interference correctors of the strain type are fundamentally of the same design as the choke type, but so designed as to be inserted directly in the high tension line connecting rectifier and precipitator buildings.

As previously mentioned, a plurality of parallel circuits exist in the precipitator installation. The interference correcting equipment should be so placed as to be included in each of the main oscillating circuits. Correctors should also be placed as close to the feeder bus of each treater section as possible. The correctors should be located as close to the treaters as possible without undue exposure to hot treater gases or high temperatures which are detrimental to the insulation. For these installations where the correctors cannot be installed sufficiently close to the treaters without exposure to high temperatures, a special type of corrector has been developed which may be exposed to temperatures up to 600 deg. F. without injury. This corrector should be installed between the precipitator and the high tension switching equipment.

The choke and absorber type correctors are provided with one-half inch standard female pipe threads for direct insertion in the one-half inch pipe high tension lines. No further connections to windings are necessary as the ends of the windings are soldered during coil assembly to the bronze ends on each corrector, and screwing the pipe into the bronze ends completes the circuit.

The strain-type correctors are so designed as to be inserted directly in the high tension lines. The correctors are inserted in the line in a manner similar to the insertion of the familiar strain-type insulators. The correctors are equipped with suitable terminals by means of which direct connection is made to the line. It is deemed necessary to insert correctors in these lines at distances of approximately 50 to 75 ft., if avoidance of all broadcast interference is to be assured.

During tests, it was noticed that sparking often occurred between pipe framework and entrance gates on the guard rails surrounding the high tension equipment. Although the entire system is grounded, considerable

current flows in various portions of the circuit. The induced currents are of very high frequencies and could be taken through the body. Small flashlight bulbs were lit with great brilliancy. The potential between one of the gates and the pipe guard rail was estimated (by sparking distance) to be approximately 1,000 volts. Such induced currents are quite common in high frequency work. Attention should be called to the fact that although the entire pipe guard railings were grounded, locally induced currents can be generated and will flow through closed loops of the system.

These induced currents generally do not cause radio interference more than a few feet from the guard railings. A quite serious form of line-radio interference may be caused, however, if exposed or open (not in grounded conduit) power or lighting wires are close enough to a part of the treater circuit carrying high frequency currents. Even a small amount of radio frequency energy may travel considerable distances over conductors. In the initial layout of an electrical precipitator or similar installation, care should be taken to see that exposed power, lighting, telephone or signal wires are not run parallel to any of the high tension treater circuits. Should it be necessary to bring such wires in the proximity (10 ft.) of treater circuits, the wires are not run enclosed in grounded (flexible or pipe) metallic conduit.

Radio currents traveling as wired-wireless or carrier-current, will produce considerable interference if allowed to get on a main distribution line extending outside the plant property. Precipitator interference which may be received only over short distances as radio will often extend for many miles if traveling as line-radio over suitable conductors. Especially is this true for conditions existing in high tension distribution lines where transformers, etc., which tend to block the radio-frequency currents, are placed considerable distances apart. It is well known that signals traveling over suitable conductors suffer less attenuation than when radiated as in pure radio. For the same power output and over good conductors, transmitted radio frequency currents can often be heard from fifteen to thirty times as far by line radio as by pure radio.

SOME OF THE RESULTS OBTAINED

The Magnolia Refining Company, at Beaumont, Texas, has recently placed in operation a single unit precipitator in an acid recovery plant. This precipitator was installed and upon initial operation the radio interference was found to be quite bad. Complaint was immediately made by the operators of the Magnolia Refining Company broadcast station, KFDM, located about five hundred feet from the precipitator. Installation of the correction equipment completely eliminated the interference.

The interference at the Alpha Portland Cement Company's plant at Cementon, New York, was of such magnitude as to seriously interfere with operation of nearby receivers. This plant has three large rectifier sets. Interference has been eliminated.

Equipment similar to that described in this report has been installed by the United Verde Copper Company, at Clarkdale, Arizona. This installation has ten rectifier sets and we are advised by Mr. F. X. Mooney, of that company that the interference there has been practically eliminated.

Similar installations have been made by Lodge-Cottrell, Limited, of England, who report complete elimination of all interference.

Low Temperature Process Produces Hard Coke

Dobbelstein oven provides for continuous operation without disturbing the coal during its carbonization

By A. Thau

Halle-Saale, Germany

LOW temperature carbonization systems may be divided into two groups, those that operate continuously and those that operate upon an intermittent cycle.

Continuous operation necessitates moving the coal through the retort in some way and this movement generally results in a product that is about 50 per cent friable breeze and 50 per cent dust. This semi-coke is valued for its calorific power and said to be a good fuel for powdered fuel firing. But the writer's opinion is that the plant that goes to the expense of a powdered fuel system must use a cheap fuel to make up for the increased overhead expense. If such a plant wants to buy fuel on a heat content basis, it need not go to the expense of dust-firing, but might better buy a good coal and burn it on ordinary grates. The physical condition of a fuel, within certain limits, has a far greater influence on its value in combustion than does the calorific power.

Another suggestion has been to mix this fine semi-coke with a binder and briquet it. Such a process has not yet proved economical in practice and it seems useless to extract the volatile matter in a carbonization process and then add further volatile in the binder, thus rendering the fuel smoky again.

It seems certain that, to get a dense and hard low temperature coke, the coal should be carbonized undisturbed. Therein lies the strength of the intermittent process. But since the heat resistance of coal is high, especially at low temperatures, the layers of coal on the retort walls must be thin if the carbonization is to be completed in a reasonable time. This results in a small throughput and, for a given output, the plant must consist of so many small retorts that the capital charges and maintenance costs make its economy very questionable.

From these considerations it is apparent that a low temperature carbonization plant can only be operated economically if a large output is assured by continuous operation and the coal is not disturbed after charging throughout the period of carbonization. It is not easy to establish such conditions. One expedient adopted is the use of a moving conveyor for carrying the coal through the retort as in the Piron-Caracristi process, where coal on a conveyor is heated by the radiant heat from a bath of molten lead, over which the conveyor passes. While this process was still in the experimental stage, I had determined by research that the transmission of heat by convection in such processes is about 7 times as great as by radiation and, in addition, that a mechanically moved device inside a heated retort does not give ideal operating conditions.

The conditions outlined above seem to be met by a process developed by Dobbelstein at Essen, Germany. This process uses a retort shown in section in Figs. 1 and 2. The center of the retort is a horizontal tube, made of steel plates, similar in design to the fire tubes

of Cornish or Lancashire boilers. This tube is divided lengthwise by a vertical wall into 2 chambers. This central tube is surrounded by an outer tube fixed at a short distance from the inner tube by a number of annular, doubled-walled cells. That part of the inner tube on the left in Fig. 1 is closed at one end and at the other is located the gas burner. The hot gases from the burner enter, by the slots shown in Fig. 2, the annular cells, around which they pass between baffles over a path sufficiently extended to heat the entire cell surfaces. These baffles also serve as staybolts, to hold the cell walls in place and prevent warping should sudden changes in temperature occur.

After the hot gases have completed their passage through the cells, exit is made through slots into the chamber on the right of the inner tube, as shown in Fig. 1. This chamber is closed on the end where the burner is and at the other end is connected to the stack by means of a flue. The whole device is carried, by means of annular rails, on rollers; so that the annular cells are revolved around the stationary inner tube. The outside shell extends only under the lower semi-circumference of the device and is a perforated plate that serves the purpose of preventing the coal from dropping out of the spaces between the cells in case a non-coking coal is being treated. The perforations allow the escape of gas from the coal as shown by the arrows in Fig. 1.

The revolving cell system is surrounded by a stationary steel housing with pipe connections on the top and one side, as shown in Fig. 1. The gases are led off through these pipes to the byproduct plant. A short seal pipe is fixed to the bottom of this housing, sealed in water, and providing a safety valve and an outlet for coke dust, tar or water that might otherwise collect in the housing.

On the right of Fig. 1, the coal hopper is seen at the top, with the feeder, made up of pistons, at its

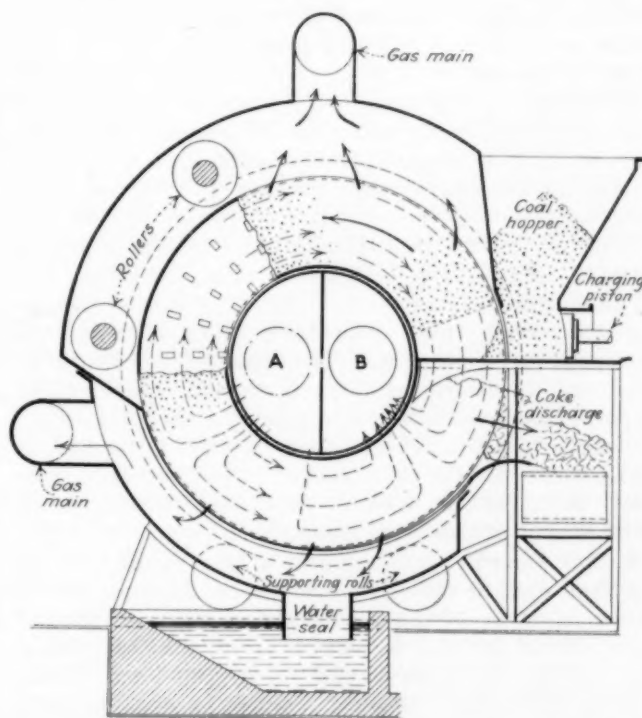


Fig. 1—Transverse Sectional Drawing of Dobbelstein Low Temperature Carbonization Retort

Hot gas is admitted at A and after passing through the heating cells escapes to B which is connected to the stack

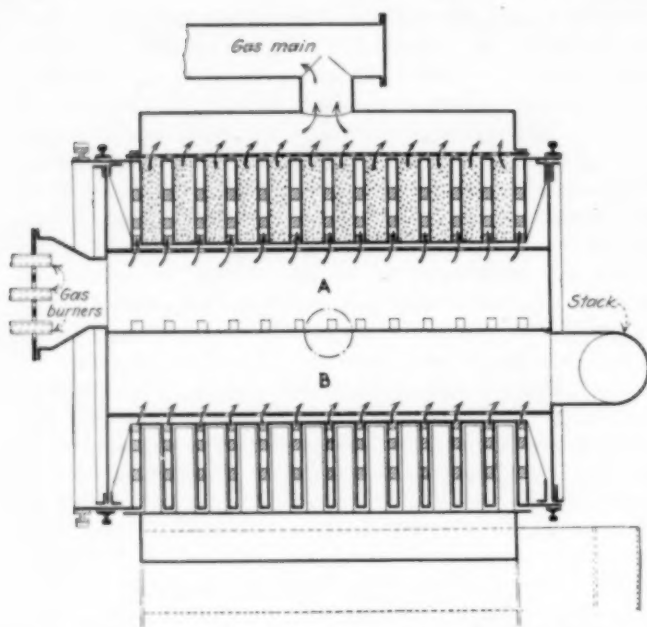


Fig. 2—Longitudinal Sectional Drawing of Dobbelstein Low Temperature Carbonization Retort

The arrows on this sketch show the passage of the hot gases through the cells from A to B and the path of the evolved gases escaping from the coal to the gas main

bottom. To prevent too great swelling of the coal in the spaces between the cells, 2 rollers, seen on the left of Fig. 1, force the coal back. The revolutions of the cell system are so timed that one revolution corresponds to the coking time of the charge and thus equals, depending on the width of the charging spaces and the type of coal charged, one revolution in from 3 to 5 hours.

Beneath the coal hopper is a stationary partition forming its bottom and made up of a number of channel irons bolted together. On the under side of each of these members is fastened a plow-shaped piece that serves to discharge the coke as the cell structure turns around and force it out into a bunker or upon a conveyor for quenching.

By means of the design described the coal is carbonized without being disturbed while continuous operation is also obtained. At the same time no dust is developed that might spoil the tar. The power consumption is low. The revolution of the cell system has nothing to do with the carbonization, serving solely as a means of charging and discharging the cells.

The distance between the cells is governed by the character of the coal carbonized, which also governs the speed of revolution. The capacity is relatively large and the length of the cell system, which can be supported by rollers at many points is only limited by the length of path that can be maintained at the proper temperature by the hot gases. The material from which the retort is made is mild steel, which should prove long wearing and inexpensive.

A trial oven, in operation over a long period, is 5 ft. long and 5 ft. in diameter. It has 10 charging spaces each 4 in. wide, giving a capacity of 10 to 15 tons of coal each 24 hours. Experiments on this oven have been carried out with a coal of 26 per cent volatile content. This coal is washed, crushed to a coking slack and contains about 10 per cent moisture. The charging pistons, which are operated by hydraulic cylinders in the trial oven, compress the coal in the cell spaces to about $\frac{1}{2}$ its original volume. The heating gas entering

the cells has a temperature from 550 to 600 deg. C., while at the flue its temperature is from 340 to 350 deg. C.

The coke produced approaches metallurgical coke in its porous structure. However, it lacks the silvery carbon deposit and is somewhat more friable. It is between metallurgical coke and gas coke in its properties, being of a denser structure than the latter and in larger lumps that are freer from large pores.

Before inspecting the plant in operation, the writer suspected that the outer layers of coal, forming the periphery of the single charges between the cells would not be carbonized completely owing to the heat losses by radiation at these points and because the heating gases traveling through the interior of the cells might not heat the outer edges as well as the center. However, this did not prove correct and the average piece of coke from the outer layers was as dense as that from near the center.

This coke contains about 10 per cent of residual volatile matter. It burns readily without visible smoke. Since there is no shrinkage in low-temperature coke the discharging device described answers its purpose well and the coke leaves the surfaces of the cell structure clean and free from any carbon deposits.

No determinations have been made as yet as to heat and power consumption, but it is expected that the results will keep well within the established limits of other plants. The trial oven is heated with coke oven gas from the nearby coke plant and the low-temperature gas, after removal of the oils and tar, is allowed to escape to the atmosphere. The trial plant was erected primarily to prove the possibility of producing a hard, lumpy low-temperature coke, some of which is shown in Fig. 3, and for this reason no particular attention has as yet been given to the production of byproducts.



Fig. 3—Some of the Coke from a Dobbelstein Low Temperature Retort

As will be seen, this coke is of a hard, lumpy nature. It is said to occupy a place between gas coke and metallurgical coke

Industrial Power Plant Piping

Notes on the design and upkeep of pipe lines for water, steam and air with reference to expansion, heat losses and other important factors.

By Theodore Maynz

Consulting Engineer, Cleveland, Ohio

PIPELINES for handling water in industrial power plants are the most important and also the most neglected lines. These lines supply water for three general purposes: steam generation, condensing and general service.

For water for steam generation, that is, for boiler feed water, the simplest layout is direct from the water supply to the feed water heater, thence to the boiler feed pump and into the boiler. However, this piping system can become very complicated, as when the water is taken from condensers and the system includes distillers, preheaters, generator and oil coolers, extraction heaters, gland heaters, de-aërating equipment, surge tanks, boiler furnace or stoker cooling surfaces, economizers (each requiring direct and bypass piping), valves, regulators, and other equipment, all designed to insure continuity of service and maximum recovery of heat.

The first requisite for a feed water system is reliability, because interruption of service involves danger to life and to property. For this reason the piping should be as simple as possible and yet sufficiently flexible so that a breakdown in any piece of equipment can be bypassed without shutting down the plant. It is a simple matter to shut down a hand fired boiler, but it is difficult to do this with a modern boiler having a stoker with several tons of coal in the furnace and a large amount of refractory surface capable of storing heat for many hours. In the matter of feed water pumps, in particular, it is well for the plant to follow the "rule of three," that is have two units that can easily carry the load and a third for stand-by and emergencies.

The simplest feed water piping system is the "loop" system, with proper cross-overs and valves, not only from the pumps to the boilers, but also from the source of supply to the heater and from the heater to the pumps. Such a system is more expensive than a straight line system, but is far more reliable, cheaper to repair, and is also readily adaptable to plant expansion. Since the temperatures involved are low, the pipe sizes small and the pressures generally low, screwed joints and flanges can be used. These will usually take care of the expansion strains, provided no direct leads are used, because a screwed joint will allow for considerable expansion provided it is given a chance to swing. Brass piping is the best, and the cheapest in the long run; but pure wrought iron will give good service for such piping, much better than steel. Sectionalizing valves can be gate valves, but regulating valves should always be renewable seat globe valves. With these latter, care should be taken that the boiler pressure is always on the under side of the disk.

Since the feed water supply is usually impure, scale will form in the pipes, even under the low temperatures involved and provision should be made for periodic cleaning.

Few plants can afford to operate without a boiler feed meter. This means that the piping layout must be so designed that a meter will register accurately. In case an orifice or Venturi meter is used with reciprocating pumps, a gage glass equipped with an air chamber much larger than that usually furnished by the pump manufacturers must be used.

The avoidance of water hammer in these feed lines is essential. When handling hot water by suction it is necessary to have a positive pressure head on the suction side of the pumps to prevent them from becoming steam bound. This is particularly essential with centrifugal pumps, where with water at 210 deg. F. the heater outlet should be set a minimum of 10 ft. above the pumps. With reciprocating pumps this distance should be 6 ft. for satisfactory operation.

As a rule, a single centrifugal pump for boiler feed service if under 100 gal. per minute is not as practical as a reciprocating pump which should be of the outside packed plunger type. A simplex pump will handle hotter water with less suction head than a duplex pump, but it is much more expensive to purchase for an equivalent capacity.

PIPES FOR CONDENSERS

If condensing water is used, enormous amounts, comparatively, must be handled. In plants having high steam pressures and main unit water rates of about 9 lb., about 1.2 gal. per minute is allowed per kw.-hr., or about 500 lb. of water for every pound of coal burned. In most industrial plants having main units with a 20-lb. water rate, this requirement will be about 600 lb. of water per pound of coal. Often this water must be recirculated and then an even larger amount must be handled per kw.-hr., because of the higher temperatures. With such large quantities of water the friction loss in the pipes must be kept low to reduce the power requirements for pumping. Also, due to the large, heavy pipes and fittings used, expansion strains must be allowed for even with the extremely small temperature changes that occur, in order to prevent distortion of pumps and breakage of pump housings. With bleeder turbines, where large quantities of steam are bled for process use, it is often possible to produce a kw.-hr. for every 4 or 5 lb. of steam going to the condenser, even with pressures of 150 lb. and no superheat. But the condensers and pipes should be large enough to take care of almost the full turbine load with no bleeding, for it may be necessary to operate in that manner. Maximum water velocities of 8 to 10 ft. per second are usually used with short pipes. Rubber, or rubberized cloth makes the best gasket materials for use with these lines.

Service water in a power plant has a variety of uses and may be low or high pressure. Where it is used for cooling stoker or furnace parts it is seldom worth while to conserve the heat absorbed by using boiler feed water because a complicated piping layout results. Water for fire and sprinkler service is in this class, as it is usual practice to place the pumps for this service in the power plant.

This service water piping is important and should be carefully laid out to provide continuity of service. Steel pipe, with screwed, malleable fittings is here satisfactory for low-pressure lines under 3 inches, while screwed flanges and flanged iron fittings should be used for larger lines. As such pipe lines are likely to sweat

and cause annoyance and expense, they should be coated with special paints, ground cork or special pipe covering.

There are two general classes of steam piping—high and low pressure. Each of these classes can be subdivided into mains and branch lines. The materials used vary with the service, from cast-iron screwed flanges and fittings to forged steel fittings and welded, gasketless Van Stone joints with forged steel flanges and alloy steel bolts. The better the materials and the design, the lower are the maintenance costs and the fewer the shutdowns. Even with steam pressure at 150 lb. and no superheat, it is false economy to use cast-iron screwed flanges and cast-iron fittings for mains or important auxiliary steam lines. Van Stone joints for large, high-pressure steam piping such as main headers, suitable gaskets, welded nozzles and Monel metal fitted steel valves make up a pipe line on which repairs are practically unnecessary for the life of the plant, provided pressures and temperatures are moderate—say up to 250 lb. and 550 deg. F.

PIPING FOR STEAM LINES

Steam lines should be well supported, either by hangers or on rollers. They should have a definite pitch for draining the condensation and should be kept drained by traps. Expansion must be calculated, not guessed, and then allowed for. It is no use placing an expansion joint or loop in a line and then providing no definite anchorage points. Laterals or outlets should always come off the top or side, never from the bottom of a main. All dead-ended risers must be drained through traps.

It is always preferable to bolt valves direct to boiler or header flanges instead of in the line, as this method avoids extra joints. The non-return valve can often be bolted directly on the boiler nozzle and the shut-off gate valve directly to the welded flanges on the header, which leaves only one joint in the pipe from boiler to header in which is inserted the flow meter orifice. If the main header is some distance from the boiler more joints will be required; but many extra joints can always be avoided by careful designing. Every joint, unless welded, is a potential trouble-maker. However, in a well-designed and constructed steam line, joint trouble can be almost entirely avoided, and if lines are periodically inspected for tightness of bolts and joint conditions they can be kept tight indefinitely.

Auxiliary steam lines are usually small in size, so that it is not an item of large cost to use the same care in design and choice of materials as is used for main lines. Flanged joints should be used throughout the header, which is best installed as a loop. Sectionalizing valves for continuous operation are necessary. Expansion and drainage must be allowed for and the support of the lines is important. High-pressure mains, as well as their branches, should be adequately insulated with insulation of a type adapted to the temperature. With superheated steam, pipes are larger and the temperature greater than with saturated steam, and therefore the insulation requirements are more stringent.

WHAT VELOCITIES TO USE

Steam velocities are quite variable. In mains, modern practice uses about any velocity from 5,000 ft. per minute up to, in one special case, 75,000 ft. per minute. For industrial plants, with moderate pressures, veloci-

ties of 8 to 1,000 ft. per minute are most suitable for mains with from 6,000 to 8,000 ft. per minute in branches and feeder lines. For high-pressure plants, larger pressure drops are allowable, so that 15,000 ft. per minute is not uncommon in central stations.

Exhaust steam lines are usually low pressure, rarely higher than 25 lb. gage. Due to their size and the usual low velocities allowed for small pressure drops, they are expensive to install in spite of the fact that low-pressure fittings and standard steel pipe are used in their construction. Because of their weight, sturdy supports are needed. These are usually rollers mounted on brick or concrete piers if the line is long, or on angle braces along a wall if it is not too heavy.

With high pressure turbines, exhausting at 100 lb. gage, the exhaust lines are in the same category as ordinary steam mains in plants of that pressure. In long lines, operating at slightly above atmospheric pressure, where the exhaust steam is used for process work or heating, steam velocities should not exceed 3,000 ft. per minute. However, the steam in these lines is usually about 55 per cent dry, so that actual volume in the pipe is lower than the specific volumes from the steam tables would indicate.

A steam pipe installed close to a wall is hard to erect or repair and ample working space should be allowed around lines. Future growth of plant should be allowed for, so that additions not only fit in with the scheme but that additional equipment does not overload the lines that are already installed. A unit system of boiler main steam piping, with adequate cross-over connections is ideal, as it permits the installation of additional capacity.

PIPES FOR AIR SERVICE

Air piping is quite simple, as the pressure is usually low, and the quantities of air handled are relatively small. Water is the main difficulty, and eliminating it by means of separators and traps, makes this piping very simple to maintain. In large air installations, such as foundry blower systems and in the steel industry, the volumes handled are large, and therefore the piping cost is a considerable item. Due to length, the pressure drop is usually quite considerable, but since the cost of power for air is rather easy to calculate, an economic balance for cost of lines versus the cost of power can be obtained.

A final word on the general design of piping for all fluids. Never have rigid connections, as all pipes expand and contract. Use as few elbows as possible, long sweeps and long radius bends might allow the use of one size smaller line with the same pressure loss. Eliminate all sag and pockets, and have a constant pitch to the line, draining at the low side. Use the best gasket material obtainable, as the cost of renewing a joint is always more than the cost of the gasket. With high pressures and temperatures, ordinary machine steel bolts will not stand up. Heat insulation with open ends, through which air can travel between the pipe and the insulation is useless. Cover all flanges and fittings. They radiate heat as well as pipe, and their surface is large. Be sure that the line is adequately supported, correctly anchored, and all expansion strains provided for. Do this—and with a good lay-out, proper materials and honest workmanship—a pipe line will function properly, cost very little to maintain, and be always tight.

Heating of Modern Coke Ovens

Variations of temperature in vertical flues and heat required per pound of dry coal with special reference to the Carl Still oven

By H. Kuhn

Recklinghausen I. W., Germany

MOST existing coke ovens are constructed with single-flame heating flues of a vertical type. In these the proper volumes of gas and air required for combustion are injected into the bottom or top of the flue simultaneously and in close proximity to each other. From this point the combustion extends upward or downward in the flue as the case may be, depending on the particular design in question. This system of heating is indicated by the sketch shown in Fig. 1.

Uniformity of heating in a horizontal direction along the walls of the coking chamber is satisfactorily attained by this arrangement of combustion by several schemes depending on the design of oven. However, uniform distribution of heat in a vertical direction is not provided for by this method. The heating flues in coke ovens are commonly from 10 to 13 ft. in height, which height is too great for a single flame burning at the base of the flue to exert a uniform intensity of heat throughout the whole distance. The volumes of gas and air admitted at the base of the flue create at their junction a maximum combustion temperature which declines more or less rapidly as the top of the flue is approached. This drop in vertical temperature explains the corresponding loss in vertical heat supply; the lower parts of the oven are overheated, while too little heat is supplied to the upper part. This fundamental defect is the cause of a chain of disadvantages.

For many years designers have attempted to overcome this defect in operation. In most designs, one-flame combustion was retained and efforts were made toward discovering auxiliary means to overcome the vertical temperature drop or to minimize its disturbing effect. However, all these attempts have resulted only in expedients of a provisional character and have not touched the fundamental technical point of the problem. The result is that, especially in the case of ovens of great height, satisfactory vertical heating conditions have not been obtained. In some cases multi-flame combustion systems have been adopted, but these have not in the past been an entire success.

A design of oven that has apparently overcome this difficulty and which has been used in several plants in Europe for some years is that developed by Carl Still. This oven is of the multi-flame vertical flue combustion type. In the flues of this oven the combustion air is admitted through ports provided at different points throughout the length of the heating flue, while the gas enters in one jet located at the base of this flue. The number of these air ports depends on the height of the oven. This combustion air is led through small channels in the walls that separate the flues, the design being as shown in Figs. 2 and 3.

The first portion of this air enters the heating flue through the first and lowest port which is located near

the gas ports in the base of the flue and this portion of the air comes in contact with the entire mass of entering gas. The supply, however, at this point is naturally greatly insufficient to permit of complete combustion and thus only a certain portion of the gas, depending on the amount of air admitted, is burned. The remaining unburned gas, together with the waste gases from this first combustion stage, moves upward to the point in the heating flue where the second air port is located. The air entering at this second port permits of the combustion of an additional quantity of the gas and this is repeated to the top of the flue as the gas reaches successive air ports. The amount of air is so graduated that the air admitted at the final and uppermost port is just sufficient to complete the combustion of the unburned gas still remaining in the flue. By a proper regulation of the air entering at each of these ports in relation to the amount of gas introduced into the tube, it is possible to regulate the heat produced so as to uniformly heat the flue from top to bottom. This system of gas combustion is also said to entirely do away with the other difficulties arising from unequal vertical heating found in some other ovens.

Few, if any, figures of temperature variations in modern coke ovens have been made public. An exception is the article by Becker (*Chem. & Met.*, Vol. 27, p. 877) which gives some statements respecting temperature variations in Becker and Koppers ovens. These measurements were taken by means of thermocouples inserted into the middle of the coke mass from the pusher platform side. The upper and lower points of measurement were relatively close together so that the temperature variations do not cover the entire length of the coke but only a fraction of it. Moreover, the time of taking these measurements was at the end of the coking period or shortly before, and nothing is said about the progression of temperatures during this period. If these figures referred to above are extrapolated so as to ascertain the variations in temperature for the entire height of the charge of coke, then the figures are as shown in Tables I, II and III.

From the tables it will be noticed that the range of

TABLE I—TEMPERATURE DROPS IN KOPPERS OVENS

No Admixture of Waste Gas with Heating Gas				
Height of Chamber..... 3.01 m.				
Gas Collecting Space about..... 0.30 m.				
Point No.	Temperature in deg. C. after a Coking Time of			
	18 Hrs. 24 Min.	19 Hrs. 24 Min.	21 Hrs. 12 Min.	
1. at the floor.....	1,011	1,042	1,070	
2. 0.61 m. above.....	983	1,022	1,056	
3. 1.81 m. above.....	928	983	1,028	
4. 2.18 m. above.....	850	911	983	
5. 2.71 m. above.....	738	808	919	
(Upper edge of cake)				
Temperature drop between lowest and highest point of measurement (1.57 m).....	153	111	73	
Temperature drop over the entire height of coke-charge (2.71 m).....	273	234	151	

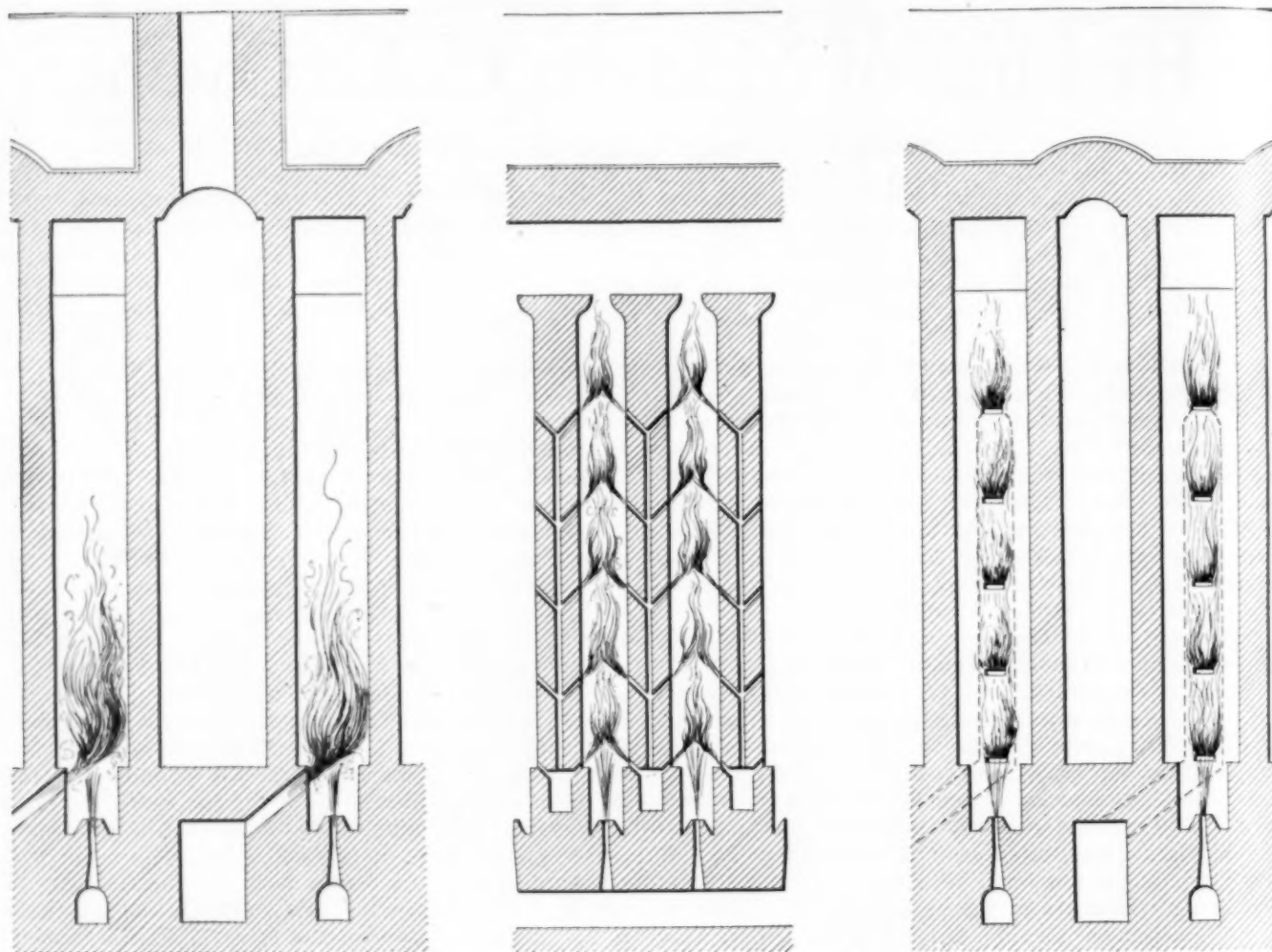


Fig. 1, 2 and 3—Comparison of Single and Multi-flame Heating Flues

Fig. 1 on left shows the single-flame flue, Fig. 2 in center and Fig. 3 on right show longitudinal and traverse cross-sections of the multi-flame flue

TABLE II—TEMPERATURE DROPS IN KOPPERS OVENS

Height of Coking Chamber.....		3.01 m.
Gas Collecting Channel about....		0.30 m.
Point No.	Temp. in °C. After a Coking Time of	
	23 Hrs. 26 Min. Without Waste Gas	23 Hrs. 18 Min. With Waste Gas
1. At the Sole.....	1,135	1,022
2. 0.61 m. above.....	1,033	979
3. 2.07 m. above.....	789	876
4. 2.37 m. above.....	735	867
5. 2.71 m. above.....	674	857
(Top of coke-charge)		
Temperature drop between lowest and highest points of measurements.....		298
Temperature drop over entire height of coke-charge.....		461
		165

temperature drops at the end of the coking period is between 129 and 461 deg. C. The greater difference, that of 461 deg., was found in a Koppers oven of approximately 10 ft. height with the normal one-flame heating system and no auxiliary means for equalizing the vertical temperature. The figure of 129 deg. C. was obtained from a Becker oven with a height of coking chamber of approximately 12 ft. In this oven, as operated for the test, there is an addition of waste gases to the heating gas which serves to retard the process of combustion and thus aids in making the heating more uniform throughout the height of the heating flue.

The extra-polation underlying the tables and figures referred to above is incomplete because it is premised on a direct proportionality between decline of temperature and height of coke charge. It is the writer's opinion that the temperature actually recedes at a

higher rate toward the top of the charge and at a slower rate toward the bottom. The above figures, then, are only arithmetical minimum values, while the actual variation in temperature would undoubtedly be higher.

As mentioned before, the figures given above relate to the end of the coking period. It is probable that variations in temperature in the vertical direction would be greater during the progression of the coking than they are at that time. This is the case because it is customary to overheat the finished lower part of the coke charge until the upper part has reached, at least approximately, the required temperature. This can be seen from Table I, where, in addition to the final temperatures, temperatures at times closely preceding are also given. It will be noticed that the upper and lower temperatures approach each other within 151 deg. C. only at the end of the coking period, while at a time 2½ hr. before this the variation is as much as 273 deg. C. A reasonably exact extra-polation of this 2½-hr.

TABLE III—TEMPERATURE DROP IN BECKER OVENS

Coking Time 10 Hours 30 Minutes		
Height of Coking Chamber..... 3.61 m.		
Gas Collecting Space about..... 0.30 m.		
Admixture of Waste Gas with Heating Gas		
Point No.	Temperature in °C.	
1. at the floor.....	1,019	
2. 0.61 m. above.....	1,011	
3. 2.80 m. above.....	983	
4. 3.18 m. above.....	914	
5. 3.31 m. above.....	890	
(Upper edge of cake)		
Temperature drop between lowest and highest point of measurement (2.57 m.).....		97
Temperature drop over the entire height of the cake (3.31 m.)		129

TABLE IV—HEATING WALL TEMPERATURES TAKEN AT THE STILL COKE OVEN BATTERY AT EMSCHER-LIPPE
(The charging holes are numbered commencing on the pusher side)

of Oven	Hole	Wall Temperatures in °C.			
		Below	Above	Plus Above	Plus Below
45	1	1,040	1,035	..	5
	2	1,050	1,050	..	..
	3	1,050	1,040	..	10
	4	1,050	1,030	..	20
	1	1,060	1,055	..	5
	2	1,060	1,060	..	..
	3	1,065	1,060	..	5
	4	1,050	1,050	..	..
13	1	1,055	1,040	..	15
	2	1,050	1,050	..	..
	3	1,050	1,040	..	10
	4	1,040	1,035	..	5
21	1	1,050	1,045	..	5
	2	1,050	1,050	..	..
	3	1,060	1,060	..	..
	4	1,060	1,050	..	10
29	1	1,035	1,030	..	5
	2	1,050	1,045	..	5
	3	1,040	1,040	..	..
	4	1,045	1,040	..	5
31	1	1,020	1,015	..	5
	2	1,030	1,020	..	10
	3	1,020	1,020	..	..
	4	1,020	1,010	..	10
37	1	1,020	1,015	..	5
	2	1,030	1,030	..	..
	3	1,030	1,025	..	5
	4	1,020	1,020	..	..
39	1	1,030	1,030	..	..
	2	1,040	1,040	..	..
	3	1,045	1,040	..	5
	4	1,030	1,025	..	5

variation of temperature in a direction back toward the start of the coking time is impossible without further knowledge of relevant factors. But it is probable that, in view of the measurably uniform approach of the upper and lower temperatures during the last few hours of the coking period and the steadiness of the temperature progression during operations, a corresponding approach took place also during a certain interval of the preceding coking time. That means that preceding variations in temperature were considerably greater than 273 deg. C.

Summarizing the above, the conclusion to be drawn from Becker's figures, which are surely not below a fair average, is that the variation in temperature in ovens heated by one-flame combustion amounts to several hundred degrees Centigrade even when the height is less than that of the test referred to. From this it would seem that the auxiliary means devised for the purpose of equalizing vertical temperatures, that is, the introduction of waste gases along with the fuel gas, is not adequate for the purpose. General experience confirms this point made from Becker's figures.

One remedy for this variation in vertical temperatures that has been repeatedly suggested is the tapering of the oven toward the top. According to Evans (Fuel Economy Review, p. 14, 1924) and also according to British patent No. 7664, 1911, this has been tried and described as far back as the eighties. Such tapering is supposed to accommodate the paths of heat transmission in the coke charge to the variations in the temperature of the heating wall. In actual practice, there are only a few centimeters available for tapering the oven toward the top, because the permissible minimum and maximum widths of chamber in a vertical direction differ but slightly from one another. For this reason, tapering as an aid to uniform distribution of vertical temperatures is confined primarily to ovens of no great height.

In the examples given in Tables I, II and III, the temperature near the floor of the oven is considerably higher than at the top. Consequently, the absolute drop

in temperature from the lower parts of the wall to the middle of the charge, where the measurements taken in such an oven as mentioned by Peischer (Stahl and Eisen, p. 224, 1925) were taken, is many times the corresponding drop of temperature in the upper part.

During the further progress of coking and after the time arbitrarily selected by Peischer, the temperature prevailing in the middle of the coke charge will, notwithstanding the longer path of transmission, rise much more rapidly than the corresponding upper temperature, because the greater temperature drop below that point stimulates a more rapid equalization of temperature below than above. The temperatures in the upper part of the charge therefore drag behind those in the lower part before the required final temperature has been reached. If, in order to prevent this, the walls were heated to a greater temperature, then the temperatures in the upper part of the charge would advance, but the ratio of advance in the lower part would be far greater. This would result in further overheating of the lower part of the charge.

These figures of Peischer's referred to above report that in a battery of coke ovens provided with conical chambers, a temperature of 800 deg. C. was reached simultaneously at two places, 1.7 meters apart in the middle of the coke charge. If, with the vertical points of measurement only 1.7 meters apart, these middle layers of charge reach 800 deg. simultaneously at a certain time, that does not necessarily mean that the coal layers above and below follow the same course. For example, all the layers immediately near the wall experience the same temperature drop as the walls themselves. This drop only diminishes gradually at some distance from the walls of the chamber. Due to the higher wall temperature at the bottom of the charge, the process of coking progresses more rapidly there than above, so that the backing up of the heat below becomes greater than it is above, and the super-temperatures of the lower parts of the wall radiate with diminishing intensity towards the middle of the charge. Thus, even the slight tapering permissible cannot bring about a uniformity of temperature until the middle of the coke charge at the junction of the tar seams is reached. The result is that, with the profile of the wall tapering toward the center line at the top of the chamber, the entire coke charge, excepting the immediate vertical middle layers, suffers more or less from the overheating below and its detrimental after-effects.

This tapering of the oven also has other inherent disadvantages, such as loss of useful coking space, complication and increased cost of construction, lengthening of the upper path of heat transmission from the middle of the heating flue to the coking chamber and the danger of wedging in this upper part of the oven if a strongly expanding coal is used.

That these variations in vertical temperatures throughout the coking charge do not hold for the Still oven is evidenced by the test given in Table IV, which shows wall temperatures taken at the first battery of these ovens built in 1917 at Emscher-Lippe Colliery, Datteln i.W., Germany, and belonging to the Krupp Works. This battery was not put in operation until 1922. When tests were taken, variations in wall temperature from top to bottom were only from 10 to 20 deg. C.

The measurements shown in Table IV were taken at random during normal operation of the battery, by means of an optical pyrometer through the charging holes at the end of the coking period immediately after

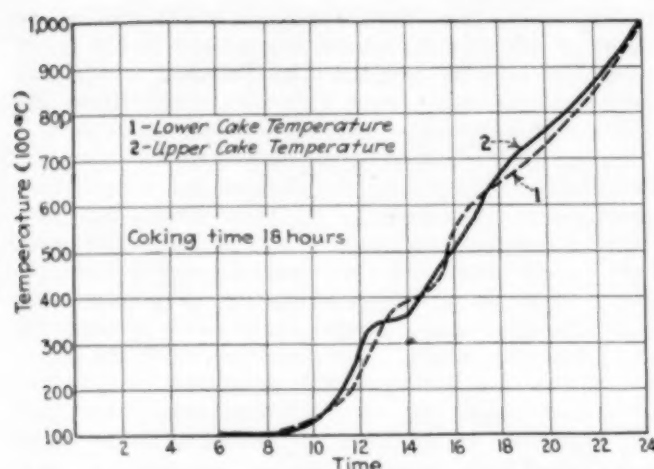


Fig. 4—Curve of Temperatures During the Full Coking Period. The observations upon which this curve is based were taken on a battery of Still ovens, 18 hour coking time, at Gleiwitz, Germany.

pushing. They represent readings of the temperature of the wall immediately above the floor of the oven and at the top underneath the abutment of the heating walls. Other measurements of temperature, taken likewise during normal operation, were given in my article in *Das Gas und Wasserfach*, Jan. 2, 1926.

The uniform temperatures of the heating walls at the end of the coking period that are shown above correspond to the uniform temperatures taken during the progression of the coking process. Fig. 4 shows a diagram of temperatures observed during the coking process at the Gleiwitz plant of Still ovens. The readings represent temperatures taken in the lower and upper part of the coke charge by means of thermocouples on the center line eight-tenths of a meter from the pusher platform side. These temperatures show that during the entire period of coking the charge was uniformly heated from top to bottom. The two temperature curves oscillate closely one around the other. They represent to a marked degree in their average course a straight line which is indicative of a mathematical reproduction of the uniform rising temperature during the process of coking; and show little room, therefore, for improvement. This result is considered remarkable because the battery, at the time of taking the readings, was operated rather slowly for the reason that the relation between coking time and byproduct recovery was also being investigated.

In an article by Wilson, Forrest and Herty (*Industrial Engineering Chemistry*, p. 231, 1923) some figures are given for gas consumption of regenerative coke ovens. For a battery of 60 ovens operating on 18-hr. coking time and using a coal with 26 per cent volatile matter and 4.6 per cent moisture, the heat required was found to be 1,100 B.t.u. per lb. This test was made in the latter part of 1921. The results were obtained by direct measurement of the quantities of gas supplied and by determination of their calorific value.

Porter on page 243 of his book, "Coal Carbonization," states that this figure of heat required varies from 1,050 to 1,250 B.t.u. per lb. He also states that in cases of exceptional efficiency and good utilization of the heat of the waste gas, the lesser of these two amounts may be used. It is thus apparent that the normal requirement is somewhere around 1,100 B.t.u. per lb. It is practically immaterial whether this figure relates to wet or dry coal, since the coal is generally coked with a moisture content of about 3 per cent, and that means that if the coal were reduced to a dry con-

dition the heat requirements would be greatly varied.

The statements of the above two authorities agree closely with the data given by Becker, who states that the heat requirements on Becker ovens of 0.36 meters width and 11 hours coking time, is 1,040 B.t.u. per lb.

These American statements correspond to the few German publications that mention these quantities. Kubach (*Gluckauf*, p. 269, 1925) publishes a statement of his investigation on three Hinselmann batteries 0.57 meters wide, 2.05 and 2.25 meters in height, the last of which was put in operation in 1924. This paper gives data that works out at about 1,120 B.t.u. per lb.

Other figures obtained from various sources check the above figures rather closely and in fact, it is usual for certain coke oven construction companies, in Germany at least, to construct ovens on a guarantee of a heat requirement of not more than 1,120 B.t.u. per lb. of dry coal. On the other hand the heat requirements of the Still oven above described generally seem to be considerably lower than those figures. Table V gives the results obtained in tests on three different batteries of these ovens, which all show heat requirements of 720 B.t.u. or less per lb. of dry coal.

An unconditional comparison of heat consumption figures such as is given above is not permissible without further comment. The requirements of heat energy for heating ovens depend upon a chain of deciding factors which differ in practice from case to case. A prime factor of this kind, as mentioned before, is the width of the coking chamber, since the narrow ovens under otherwise equal conditions require much less heat than do the wide ovens. Likewise the height of the oven, which in the case of one-flame heated ovens determines the over-coking period and the attending heat losses, is a decisive influence. Also, the conductivity of the refractory material used for building the ovens is of importance. This last factor precludes comparisons between European and American practice, as the silica refractory construction used in the United States is not yet customary in Europe. Other conditions such as the efficiency of regenerators, the kind and gas content of the coal used, the rapidity of the coking process, and degree of coking and the method of charging the ovens are among the factors that influence this figure. In order, therefore, to make an exact comparison it would be necessary to reduce all these different heat requirements to some similar basis.

It is the writer's impression that the heat requirements of the multi-flame type of oven are considerably lower than the above mentioned German and American figures. This is because the uniform vertical heating eliminates various heat losses that occur in other designs. A point of prime importance is the fact that the overheating of the bottom part of the coke charge is avoided. Another reason for the lower heat requirement of this type of oven heat seems to be due to the cutting down of the excess air necessary for combustion in other types.

TABLE V—HEAT REQUIREMENTS OF STILL COKE-OVENS

	Emascher-Lippe Datteln i.W.	Gustavgrube Rothenbach N.S.	Bargood Colliery England
Constructed in the year	1917	1923/4	1923/4
Number of ovens	100	45	50
Material used in Oven-Chambers	Chamotte	Silica	Chamotte
Average width of Coking Chambers mm.	510	440	480
Volatile matter, per cent.	17-18	21-23	18-20
Moisture in coal, per cent.	abt. 9	abt. 14	abt. 11
Heat requirement B.t.u. per lb. wet coal	792-830	817-878	794-819
Heat requirement B.t.u. per lb. dry coal	688-735	648-720	659-698

Muriatic Acid—Staple Product of the Heavy Chemical Industry

How one of the most useful of the important mineral acids of commerce is produced and marketed to a wide variety of industries

By William M. Rand

Vice President and Sales Manager, Merrimac Chemical Co., Boston, Mass.

MURIATIC acid, the hydrochloric acid of commerce, is a clear, pungent liquid. The commercial grade is yellow in color, although hydrochloric acid in its pure state is colorless. The technical strengths are 18 deg., 20 deg. or 22 deg. Bé. The 18 deg. grade contains 27.92 per cent HCl, the 20 deg., 31.45 per cent, and the 22 deg., 35.21 per cent HCl.

Impurities common to muriatic acid are iron, chlorine and arsenic. For certain uses, such as in gelatine manufacture, muriatic acid must be free from arsenic; too much chlorine injures the product for use in pickling steel. Although the acid is highly corrosive to most metals, it has but little effect on wood and practically no effect on rubber.

The acid was known to the ancients and was obtained by the treatment of salt and green vitriol. As a gas it was known in the early days of the alkali industry because of the nuisance it created around the plants of the alkali manufacturers. The gas emitted into the air during the manufacture of salt cake destroyed whatever it touched, and if it was absorbed by water it killed fish, injured ships and docks and in general was a nuisance. The muriatic acid was a disagreeable byproduct in the production of salt cake. Now times have changed. The former nuisance is one of the most useful of chemicals. Now sodium sulphate is the byproduct and hydrochloric acid the principal product.

In a number of its industrial applications muriatic acid parallels sulphuric acid and is a close competitor in variety of uses. One of its most important uses is in the working of metals. It is used in pickling iron and galvanizing. Wire mills require large quantities for this purpose. It is used in electroplating. In etching, it is, with nitric acid, a solvent for gold. One of its most important uses is in the manufacture of gelatine and glue. There it is used in removing the mineral matter from bones to make ossein. Sugar mills use large quantities to neutralize the alkaline sediments remaining in their tanks. It does not injure wool, while it destroys the cotton and other fibers that may be mixed with it. It is used in the manufacture of a number of intermediates for dyestuffs and in the manufacture of some of the coal tar dyes. It is used in

purifying sand and clay for use in pottery and in the manufacture of glass. It is employed in large quantities in the manufacture of soldering flux—chloride of zinc. It is used in the textile industry in dyeing and printing, also for the manufacture of some artificial silk and cotton goods.

There are some seasonal variations in the sale or consumption of muriatic acid, mostly in sugar grinding and in the gelatine business. The grinding in the cane countries takes place from December to May and most of the muriatic acid is used in this period. In the gelatine business manufacturing through the hot summer months is difficult so most of the muriatic acid is used in this business from September to May. For most other uses the acid is in steady demand.

It is difficult to ascertain the percentage of muriatic acid each industry consumes. The estimates of *Chem. & Met.*, published in the January, 1926, issue, were as follows:

Heavy chemicals	23	per cent
Iron and steel	19	" "
Fine Chemicals	14	" "
Glue	13	" "
Textiles	11	" "
Dyes	6	" "
Glucose	3	" "
Soap	3	" "
All other uses	8	" "

100 per cent

Manufacturers in Niagara Falls district would probably feel that heavy chemicals and iron and steel were the most important users, while New England lists (1) iron and steel, (2) glue and gelatine and (3) textiles as the three largest consumers. In other districts other industries are the important users.

There are 37 manufacturers of muriatic acid, located in Massachusetts, New Jersey, Connecticut, New York, Pennsylvania, Indiana, Illinois, Ohio, Delaware, Kansas, Colorado, Michigan, Louisiana and California. The total production amounts to about 200,000 tons.

Method of Manufacture—Muriatic acid is made by the treatment of common salt with sulphuric acid, the fumes escaping from this reaction are absorbed in

MARKETING

Muriatic acid is one of the oldest chemical products and in its wide range of industrial applications it is second only to sulphuric acid. Its market while closely related to that of sodium sulphate is also affected by unusual shipping requirements and the demand for various grades and concentrations. These are the characteristics that are discussed in the second of Mr. Rand's articles on the Marketing of the Mineral Acids.

CHEMICAL PRODUCTS

water. The reaction of salt and sulphuric acid takes place in muffle furnaces. The gas may be purified by various processes before it is absorbed in water. Muriatic acid and salt cake may be produced directly from salt and SO_2 by the Hargreaves-Robinson process. This method is not widely used at present, although it may become more important in the future. Large quantities of muriatic acid are also made as a byproduct in the electrochemical manufacture of caustic soda.

Availability of Raw Materials—The raw materials for the manufacture of muriatic acid are salt and sulphuric acid. The supply of salt is unlimited and sulphuric acid is manufactured to the extent of about seven million tons a year in the United States. Important changes in technology have affected the industry in that synthetic acid is now made by the chlorine manufacturer where formerly all of the acid was made by the chemical process of treating sulphuric acid and salt. The present methods of manufacture are very well standardized, and there are few processes other than the standard ones that appear successful.

The industry of producing muriatic acid, compared with other industries in capital invested and in sales, is not important. There is a sale of about \$4,000,000 a year of muriatic acid. There are but few companies dealing in muriatic acid alone although most of the large heavy chemical manufacturers are making it as one of their staple products.

Centers of Distribution—Boston, New York, Philadelphia, Cleveland, St. Louis, Chicago, New Orleans, San Francisco are the principal centers of distribution.

Prices—The price for acid in large amounts is quoted by the pound or by the ton, f.o.b. the works of the seller. For past years the prices of muriatic acid have been as follows:

Carboys in Carloads		
1871		\$2.55
1881		1.30
1891		0.90
1901		1.00
1911		0.95
1913		0.95
	Low	High
1915	\$1.40	\$3.30
1916	1.80	5.30
1917	1.60	1.90
1918	2.00	3.00
1919	1.50	2.00
1920	2.50	2.62
1921	1.75	2.40
1922		1.75
1923		1.50
1924		1.50
1925		1.50

Shipping Requirements—There is no fire hazard in the handling of muriatic acid but it must be shipped under the class of "corrosive liquids." The carboys in which the material is sent must meet with specifications of the Interstate Commerce Commission. Muriatic acid is packed in small bottles, in standard carboys containing approximately 13 gal., in drums which are rubber lined, in tank wagons and in tank cars. As muriatic acid has a strongly corrosive effect on most metals, no metal containers which are not rubber lined are used. The drums, which are now coming into use for the transportation of this material are lined with hard

rubber, as are the tank trucks and the new tank cars. Formerly tank cars were made with wooden tubs without lining. These are still used but are not as suitable as the modern rubber-lined tubs. Muriatic acid tank cars have six units containing about five tons of muriatic acid to a unit. These tubs are laid endways or placed upright on the cars. There is also a type of single-unit tank car containing about 30 tons of acid. For the iron and steel industry, for the sugar industry and for gelatine and glue manufacture, the usual container is the tank car. The tank car conveys the acid to the consuming plant where it is stored in rubber-lined tanks until used.

SALT CAKE OR SODIUM SULPHATE

It is difficult to discuss the muriatic acid market without a reference to the sodium sulphate market. Sodium sulphate is an important chemical, closely allied to muriatic acid, for with every three tons of muriatic acid made by the salt and sulphuric acid method there are two tons of salt cake produced. Sodium sulphate is sold in a number of different forms. As it comes from the muriatic acid furnaces it is salt cake, when crystallized it is glaubers salt, or it may be calcined to produce anhydrous sodium sulphate.

The first of these, salt cake, is sold as 93 per cent to 97 per cent available Na_2SO_4 , and is used in the manufacture of glass and also in sulphate pulp. When purified as calcined glaubers salt or anhydrous sodium sulphate containing 99.2 per cent Na_2SO_4 , it is used by the dye manufacturers for salting dyes. It finds a use as a boiler compound. Salt cake is used in the sulphate pulp mills for the production of coarse wrapping papers and paper bags. The textile industry counts glaubers salt important in dyeing and printing bright and level dyes. It is also used as an assistant in cotton dyeing. It is an ingredient in the manufacture of soap, and also in sulphonating oils. The veterinary uses considerable quantities of glaubers salt. The anhydrous salt is used as a standardizing agent in dye making and as a diluent in half refined tartar.

Anhydrous sodium sulphate and salt cake are sold in powdered form, salt cake in lump or powdered and glaubers salt in crystalline form. Care must be taken that no iron gets into glaubers salt, for iron spoils it for use in the textile industry. The glass manufacturer is particular regarding the percentage of sodium sulphate and the purity of the cake. The paper manufacturer is not so particular but he must have a good quality of material.

There is produced about 150,000 tons of salt cake in the three forms mentioned above. The centers of distribution and process of manufacture are practically the same as muriatic acid. There is no danger in the shipment of sodium sulphate. It may be packed in bags, barrels or in bulk on cars. The prices are quoted by the ton, f.o.b. sellers' works.

Seeger Cones as a Time-Temperature Integrating Device

In their article by the above title, W. K. Lewis and E. D. Ries wish to say that on p. 154 of the March issue the headings of the two upper figures should be reversed. The one at the left should read: Fig. 4, Cone No. 014a; and the one at the right, Fig. 2, Cone No. 018.

Recent Legal Decisions

Digest of typical cases decided in high courts, illustrating principles of law applied to business transactions

"THE PATENTEE MUST BE THE FIRST INVENTOR"

The above quotation from an opinion of the U. S. Supreme Court delivered by Associate Justice Holmes settles an important point in patent matters. The decision was rendered in the case of Davis-Bournonville Co. vs. Alexander Milburn Co. for alleged infringement of an oxy-acetylene cutting torch. The plaintiff's patent, No. 1,028,410, was granted to one Whitford, application having been made on March 4, 1911 and patent issued on June 4, 1912. The defense was that Whitford was not the first inventor, but that one Clifford invented the idea. His patent was filed on January 31, 1911, before Whitford's, and was issued on February 6, 1912. Clifford's patent gave a complete and adequate description of the thing patented by Whitford but it did not claim it. Despite the failure of Clifford to claim the invention described in this process, the Court held that the disclosure had the same effect as the publication of the same words in a periodical, which is recognized as a bar to claiming invention. Even though Clifford's patent was not issued until after Whitford's was applied for, "the delays of the Patent Office ought not to cut down the effect of what has been done. * * * We see no reason in the words or policies of the law for allowing Whitford to profit by the delay and make himself out to be the first inventor when he was not so in fact. * * * The question is not whether Clifford disclosed himself by the description to be the first inventor. * * * The question is whether Clifford's disclosure made it impossible for Whitford to claim the invention at a later date. * * * The fundamental rule, we repeat, is that the patentee must be the first inventor."

Other patents of the Davis-Bournonville Co. involved in the litigation were No. 880,099, for a welding torch and 874,666 for a cutting torch. Patent No. 880,099, was held to be invalid in both the U. S. District Court for the Southern District of New York, and the Circuit Court of Appeals for the Second Circuit. Patent No. 874,666 was held valid and infringed, and the Alexander Milburn Co. must account to the Air Reduction Co., which acquired the assets of the Davis-Bournonville Co. prior to the trial, for profits accruing from the manufacture and sale of cutting torches involving the invention of this patent.

EMPLOYER'S RIGHT TO PATENT DEVELOPED BY EMPLOYEE

In the case of Hooven, Owens, Rentschler Company vs. Leinert in the U. S. District Court, Southern District of Illinois, it was shown that the defendant was patentee of an improvement in valves for compressors and that the plaintiff company had taken an option on the patent for one year, paying \$2,000 cash and agreeing to pay a balance of \$8,000 if the option was exercised. The company failed to exercise the option, but subsequently employed Leinert as a salesman and valve expert. During this subsequent employment Leinert applied for patent on improvements in valves and the company sought to compel him to assign the patent to it. The Court decided in favor of Leinert, holding that, the company having failed to exercise its option, it had

no right to an assignment of patented improvements. There is a distinction between the case where a patentee owns a patent before entering an employer's service, which he improved during his service on his own time, and cases where an employee develops a new invention which he is employed to develop during his term of employment using the employer's labor, material and time in doing so.

In a similar suit by the Manton, Gaulin Manufacturing Co. vs. Colony, before the Supreme Court of Massachusetts, it was shown that the defendant was employed as a machinist to manage and supervise the construction of patented machines. He invented an improvement on the patent used by the plaintiff company and conferred with the plaintiff's president about it. Whatever money was spent in reducing it to practice was spent by the defendant. He was not expressly employed to develop any particular process or machine and never agreed to assign to the plaintiff any patent he might procure. Upon these facts, among several others, the Court held that judgment for the defendant should be affirmed.

METHOD OF MAKING HYDROFLUORIC ACID

In the case of General Chemical Company vs. Aluminum Company of America, the plaintiff charged the defendant with infringement of patent No. 1,150,415, granted to H. B. Bishop, for the manufacture of hydrofluoric acid. The chemical and thermal principles used by Bishop were in themselves known, as was also the idea of a continuous process in hydrofluoric acid making. Bishop devised two methods, one to agitate the batch in a revolving drum; the other, to use a stationary circular tank and stir with revolving blades. In both, the vessels were inclined and the downwardly traveling charge was subject to progressively increased heat. The revolving drum process was the apparatus he described in his specification; the second in general form was the apparatus used by the defendant. Bishop was convinced that the second process was no good and he entered a disclaimer of the rotary stirring process. The U. S. Circuit Court of Appeals, Third Circuit, held that Bishop had surrendered the second process to the public and restricted his invention to a revolving drum. Accordingly the bill was dismissed.

EFFECT OF DELAY IN APPLICATION FOR PATENT

In the case of Hambuechen vs. Schorger, relating to the invention of a dry cell, the principal advance over the prior art consisted in dipping the core of the cell "in a magma to form a bibulous envelope therefor." Schorger conceived and reduced the invention to practice in August, 1917. He applied for a patent November 19, 1918, which was issued September 23, 1919. Hambuechen had conceived the invention early in 1916 and reduced it to practice in April of that year. However, he did not file his application until February 4, 1920, more than two years after Schorger's invention had been in public use and more than four years after his own conception and reduction to practice. Hambuechen explained that the delay was incurred by subjecting the cells to a life test. The Court of Appeals, District of Columbia, decided that such delay was inexcusable and that Hambuechen could not secure a patent in any case because of the two-year public use of the device. Under the facts he could not deprive Schorger of the reward of his work.

On the Engineer's Book Shelf

Heat Transfer and Evaporation

HEAT TRANSFER AND EVAPORATION. By *W. L. Badger*, professor of chemical engineering, University of Michigan; consulting engineer, Swenson Evaporator Company. The Chemical Catalog Company, Inc., New York. 306 pp. Price \$5.

Coincident with the development of chemical engineering as a distinct profession, it is appropriate that a book literature be fostered. With the appearance of Walker, Lewis and McAdams' work three years ago, an excellent foundation stone of American practice was laid; and with the ever-increasing complexity of industry, there has arisen a strong demand for specialized books on the unit operations. Professor Badger's work has to do with two of these unit operations—heat transfer and evaporation.

In the preface, the author says that the book "was begun with the ambitious intention of a comprehensive work on heat transfer in all its phases," but that this idea was modified after the writing of six chapters. Strangely enough, the author's weakening in ambition has resulted in an usually valuable book. There is sufficient theory for the complete understanding of the more practical treatment of evaporator calculations and applications which appear subsequently; and it is left for the reader to take what he wants or needs, without sifting laboriously through countless derivations.

About one-third of the book is concerned with the theory of heat transmission, and with heater design. This is followed by another third comprising a description of evaporator bodies, heat transfer in evaporators, calculations for multiple-effect evaporators and multiple-effect operation. The final third takes up evaporator auxiliaries, applications to specific industries, cost data and appropriate appendixes. Numerous references to the periodical and patent literature add greatly to the utility of the book.

It is a good thing to have original books of this high standard appear in the English language, and it is felt that Professor Badger's efforts should be appreciated as being a notable contribution to chemical engineering literature.

Principles of Industrial Organization

PRINCIPLES OF INDUSTRIAL ORGANIZATION. THIRD EDITION. By *Dexter S. Kimball*, professor of industrial engineering and dean of the College of Engineering, Cornell University. McGraw-Hill Book Company, Inc., New York. 436 pp. Price \$4.

Reviewed by *Chaplin Tyler*

"Engineering the element of surprise out of business" was the apt phrase used by an authority on engineering education when he described the tendency of manufacturing industries to put each major economic function on a truly scientific plane. Dean Kimball's book, the first edition of which appeared in 1913, has been a big factor in the moulding of modern thought in management and organization, and to the end that these are essentially fields for the engineer.

The scope of the book is much broader than the title would indicate. The first four chapters comprise a review of industrial history, and for the reader who has not studied this subject, such a method of presentation forms an excellent background for subsequent chapters. Chapters V, on forms of industrial ownership, VII, on principles of organization, and VIII, on co-ordination and executive control, are fundamental in nature, and lay a foundation for the detailed discussion of functional activities that follow. Chapter VI, on location, arrangement and construction of industrial plants, is somewhat of a digression.

Beginning with Chapter IX, the book is concerned with functional control, that is, a consideration of classification, identification, production control, standardization, time study, supervision of personnel, compensation of labor, purchasing, stores and stock, inspection, cost finding and administration. The chapters on cost finding and depreciation are excellent summaries of modern practice, and clarify many points left inconclusive by other authors.

Careful reading of "Principles of Industrial Organization," reveals a forceful exposition of management principles as applied to manufacturing in particular, and it is rather by that designation that this sound work should be known among engineers.

Industrial Fermentations

INDUSTRIAL FERMENTATIONS. By *Paul W. Allen*. Chemical Catalog Company, Inc., New York. 424 pp. Price \$5.

Reviewed by *Earle R. Pickett*

The need for a book of this type has long been recognized and Dr. Allen has succeeded admirably in filling portions of this need. From a great mass of literature he has selected the most important data and methods and he has presented them in a very clear and readable manner.

The book will be appreciated by the general reader because it covers the important subjects well without going into too great detail. The special works on each subject will, of course, have to be read by those more deeply interested.

The subjects of breadmaking, corn products, food preservation, and dairy products are especially complete and thorough. Bread yeast, marine products, cane and beet sugar, industrial alcohol, disinfectants, sewage disposal, etc. are amply treated for a general survey.

The chapters on tobacco, acetone and glycerine, fruit juices, and coffee and cocoa are rather short and superficial. For instance, there is no information given concerning the fermentation of tea and only a page given to coffee and cocoa. The work of the Dutch and French tobacco monopolies has not been considered.

The book is very well arranged and in most chapters a sufficiently complete bibliography is given at the end. In spite of the cursory treatment in the places noted, the book will be of great value to any reader.

Principles and Practice of Industrial Distillation

PRINCIPLES AND PRACTICE OF INDUSTRIAL DISTILLATION. By the late E. Hausbrand, translated by E. Howard Tripp, joint editor of the *Journal of the Society of Chemical Industry*, from the fourth, new and enlarged German edition. John Wiley & Sons, Inc., New York. 300 pp. Price \$5.

Reviewed by W. L. McCabe

Two quite distinct methods have been used in the development of theoretical engineering. The first method is the development of all possible simplified procedures, which start with fundamental laws and data and which can be used quickly and directly for obtaining desired results, independently of elaborate tables, graphs, and interlocking formulas. The second method consists in establishing results once for all; results which may be entirely empirical, or which may be established by elaborate mathematical reasoning, involving formula piled on formula, or which may be obtained by systematic calculation of many arbitrary combinations of the variables concerned and exhibited in tables and graphs. When the task is completed, the results can be used as they stand, and the process of derivation forgotten.

Hausbrand is a master of the second method, and in his book the theory of ideal rectification of binary mixtures is intensively worked out and the conclusions given in formulas, tables and graphs. Hausbrand restricts himself to "perfect plates." He says nothing about the factors determining plate efficiency, gives packed columns but scant mention, and does not consider constructional details. The utility of this elaborate presentation of fractionating column theory is open to question, since there are available simple and rapid methods based on the first type of reasoning mentioned and which are based only on heat and material balances and the properties of the binary mixture in question, and by the use of which the ordinary calculations can be made. However, Hausbrand's use of questions which are taken up one by one, discussed, and definitely answered, is an effective method of emphasizing the important points.

The book consists of three parts. Part I develops a general mathematical theory of fractionating columns. Part II applies the theory to specific binary systems, such as ethyl alcohol and water, methanol and water, acetone and water, methanol and ethyl alcohol, nitrogen and oxygen, water and nitric acid, and others. At the end of this part, there is a discussion of Dolzalek's method of calculating vapor composition curves. Part III consists of a large number of tables and graphs, which give the physical properties of the substances of Part II, and the results of calculations of many special cases of feed strength, product strength, and reflux ratio, for the above mixtures.

The translation by Mr. Tripp is deserving of much praise. The German constructions are completely obliterated and the resulting English is clear, readable, and free from errors.

Daytonising Chemistry

To the Editor of *Chem. & Met.*:

Sir—The author of a popular college chemistry text received the following note recently from his publishers: "Professor X, of Y College (a sectarian institution in the Middle West), has discontinued the use of your

book in his classes. One reason is the amount of space devoted to liquor; methods of producing, etc."

The said author, considerably astonished that his volume was capable of being considered a Bootlegger's Manual, carefully examined the last edition (1922) to see exactly what references to alcohol and alcoholic liquors were to be found therein. He discovered only three paragraphs, occupying two pages in all, headed "Fermentation of Sugars," "Fermentation of Starch," and "Industrial Alcohol" respectively. Wine, whisky and beer were mentioned but once, in a single sentence which merely told the source of each product, and no intimate manufacturing details were disclosed. Comparison with an earlier pre-prohibition edition showed that this contained four significant paragraphs, entitled "Alcoholic Fermentation," "Common Alcohol," "Commercial Alcohol, Whisky and Beer," and "Denatured Alcohol" respectively.

As a result of this examination, the author honestly feels that he has accommodated his last revision to the Eighteenth Amendment of the Constitution as closely as he possibly can, and wonders whether it is really expected of him to go the limit and to omit all mention of fermentation and the uses of alcohol in chemical industry in future editions of his texts. Some teachers would perhaps welcome such a procedure. Some might approve specific statements such as: "When sugar ferments a highly poisonous gas is evolved. The residual liquid also contains an exceedingly dangerous substance, formerly known as ethyl alcohol. It has no possible industrial or other uses." The majority, however, will certainly prefer to present the topics of fermentation, fractional distillation, the properties of alcohol and its many applications to chemical industry to their students from a strictly unprejudiced scientific view-point, leaving the Volstead Act out of the class-room entirely.

Is the chemistry of the future to be a censored science? Are professors of chemistry to be put on trial for mentioning alcohol in their lectures, just as teachers of biology have been for discussing evolution? If so, why stop at alcohol? Why not prohibit all reference to chlorine, in accordance with the international agreement with respect to gas warfare? Why not restrict research work on alien elements such as germanium, in order to stimulate the development of more deserving metals such as columbium and illinium?

The above questions may seem ridiculous to the scientific few, but it is by no means inconceivable that the extremists among the reformers will make a serious effort in the near future to prohibit by statute all mention of the preparation and properties of "rum" in native chemical literature. The next generation of chemists may quite possibly be forced either to use "denatured" texts, or to pursue their studies in secrecy from volumes imported by a reliable "booklegger."

Jamaica, B. W. I.

E. CARBINOL.

Paternalism in Industry

To the Editor of *Chem. & Met.*:

Sir—In my letter on "Paternalism in Industry" in your March issue, you printed "undeserving" for "undisturbing." This error makes me seem to condemn employees as not deserving pensions and insurance. Such is not my attitude.

P. B. McDONALD.

New York City.

Recent Articles in Technical Periodical Literature

Cross Cracking Plant. Description, with diagrams and photographs, of the Cross cracking installation of the Medway Co. *Ind. Chemist*, March, pp. 113-22.

Hydrogenation of Paraffin Wax. Further investigation of the liquid reaction products obtained by the action of hydrogen on paraffin wax under high pressure at 450 deg. C.: Contribution to the knowledge of Berginization. Comparison of products formed in coking and in hydrogenation of coal. The hydrogenation process is illustrated with tables and curves. H. I. Waterman and A. F. H. Blaauw. *Recueil trav. chim. Pays-Bas*, March, p. 284-95.

Cracking of Paraffin Wax. Cracking of paraffin in the vapor phase by means of activated charcoal. H. Herbst. *Z. angew. Chem.*, vol. 39, pp. 194-6.

Petroleum. Review of the petroleum industry and its methods from a practical and economic point of view. Robert Kuhn. *Chem. Ztg.*, vol. 50, pp. 113-5; 154-6.

Low-Temperature Coking. Examination and adapting of coals for successful low temperature coking. Determining optimum coking conditions from the characteristics of the coal; choice of powdered or lump size for coking; treatment of the gas and tar. Illustrated. Ernst Laszlo. *Chem.-Ztg.*, March 10, pp. 173-5.

Canadian Fuels. Carbonization of Canadian fuels (cont'd.). High and low temperature processes as applied to wood, peat and blended coals. Low temperature coke would probably not be popular as a household fuel in Canada. R. E. Gilmore. *Can. Chem. and Met.*, March, pp. 51-4.

Studies made at the Mines de la Sarre on low temperature carbonization. Sufficient progress has been made to constitute a real contribution to the fuel supply problem in France. Illustrated. J. Sainte-Claire Deville. *Chim. et Ind.*, Feb., pp. 163-72.

Benzene Plant. A thoroughly modern installation for byproduct benzene recovery (tar oil scrubbing process) is described and illustrated. G. Illert. *Chem.-Ztg.*, March 3, pp. 153-4.

Refining Vegetable Oils. Economic factors in the modern refining of vegetable oils. Refineries should cheapen their power by using high-pressure steam, efficient turbines and steam accumulators. Economies in water supply and labor costs by use of modern devices, and loss prevention by byproduct recovery, are also urged. F. Mariani. *Giorn. di chim. ind. ed appl.*, Jan., pp. 8-11.

Insulating Oils. Deterioration of insulating oils on standing involves oxidation. The test for breakdown tension be a prolonged exposure to somewhat less than the "breakdown tension," rather than the short test of increasing current tension to failure. Hans Stager. *Zeit. angew. Chem.*, March 4, pp. 308-16.

Catalytic Oxidation of Ammonia. Rapid oxidation of NH_3 on Pt can be effected even at 160 deg., but the chief product is N_2 . With rising temperature

the yield of NO increases; above 550 deg., NO is the chief product. Though the yield again falls off at high temperatures, it is possible at 1,000 deg. to adjust the gas stream velocity so as to obtain a yield of 90 per cent or better. The article contains numerous curves and tables and cites many references. L. Andrussow. *Zeit. angew. Chem.*, March 4, pp. 321-32.

Sulphuric Acid from Gypsum. Description of the process for manufacturing sulphuric acid from gypsum as operated by the F. Bayer & Co. W. J. Müller. *Z. angew. Chem.*, vol. 39, pp. 169-74.

Rayon. Manufacture of viscose silk. (Cont.) E. Wurtz. *Chem. Apparatur*, vol. 13, pp. 25-7; 39-41.

Casein Plastics. Raw materials; world production; competition with celluloid; uses of casein products. Marc Fontaine. *Revue gen. matieres plastiques*, Feb., pp. 92-8.

China Clay. The processing of naturally occurring china clay includes washing, refining by an elaborate elutriation procedure, and drying. For certain uses, as in paper and textiles, further purification to remove iron and organic matter is necessary. China clay has many uses in the chemical and related industries. E. J. Lewis. *Ind. Chemist*, March, pp. 99-100.

Leather Manufacture. Chemico-histological study of leather manufacture. I. Structure and properties of freshly flayed steer skin. The microscopical structure of steer skin is illustrated with photomicrographs and is discussed in detail. Hide substances and their relation to tanning and the processes which precede it are also taken up. Harold G. Turley. *J. Am. Leather Chem. Assocn.*, March, pp. 117-56.

Waste Recovery. Recovery and use of waste products. IV. Tannery and leather trades' waste. The primary advantage in recovering tannery wastes is to prevent stream pollution and like nuisances; but there are some uses for spent tan, leather scrap, soaking pit liquors and other byproducts. Leather scrap, for example, is a source of charcoal and of pyrrol bases and is used in fertilizer and in road making. *Ind. Chemist*, March, pp. 122-6.

Roasting Lime. Roasting and burning of ores, lime and the like. A new (patented) process roasts materials in a current of hot gas without contact with any flame or fuel, thus avoiding the disadvantages of direct firing. Illustrated. Anton Apold and Hans Fleissner. *Chem.-Ztg.*, March 3, pp. 156-7.

Water Softening. Modern British practice in water softening. VI. Zeolite or base exchange plants. The Boby-Azed, Kennicott and Permutit methods are illustrated and described. David Brownlie. *Ind. Chemist*, March, pp. 108-12.

Heat Economy. Heat economy in chemical plants. Recent advances in boilers for high pressure steam are described and illustrated. Waste heat should be utilized in one or more of the several possible ways. Blaschke. *Chem.-Ztg.*, March 17, pp. 189-91.

Heat Economy. Discussion of the principles of heat economy in modern chemical engineering. C. Weissbach.

Apparatebau, vol. 38, pp. 30-2; calculations on the combined use of steam for power and heating purposes. H. Winkelmann. *Apparatebau*, vol. 38, pp. 42-4.

Adsorption. Recent progress in technical adsorption processes. R. Koetschau. *Z. angew. Chem.*, vol. 39, pp. 210-3.

Adsorbent Carbon. Use and revival of adsorbent carbon used for decolorization. B. Block. *Chem. Apparatur*, vol. 13, pp. 27-30.

Electric Purification of Gases. Review of recent progress in the purification of gases by the Cottrell process. Emil Zopf. *Chem. Ztg.*, vol. 50, pp. 81-2.

Industrial Hydrogen. Manufacture of electrolytic hydrogen for hydrogenation of oils. (Cont.) E. Knowles. *Chem. & Ind.*, 1926, vol. 45, pp. 137-8.

Materials of Construction. Use of aluminum tanks in the transportation of heavy chemicals. Anon. *Apparatebau*, vol. 38, pp. 39-40; application of cast iron and acid-proof enamel as materials of construction. B. Liebing. *Apparatebau*, vol. 38, pp. 49-50.

Filter Cloth. Use of cotton filter cloth considered from a theoretical and practical standpoint. Leo Stein. *Chem. Ztg.*, vol. 50, pp. 97-8; 110; 125-7.

Dangerous Chemicals. Safe packing, storage, use and transport of explosive and flammable substances and of chemicals which become dangerous by contact with water, etc. H. Joshua Phillips. *Ind. Chemist*, March, pp. 127-30.

Air Pumps. Modern direct electric drive centrifugal air pump. A high speed water cooled chemically resistant pump, useful for high vacuum and for pumping wet air or chemical gases or vapors. It has no valves or piston rings and is nearly noiseless. Illustrated. Carl Hesse. *Chem.-Ztg.*, March 3, p. 157.

Sludge Pump. Description of a new type of pump especially adapted for sludgy solutions and avoiding the scouring action of the solid on the pump parts, thus securing long life. M. Berger. *Apparatebau*, vol. 38, pp. 50-1.

Magnetic Separators. Types and construction of machines; their uses in making starch, linoleum, hard rubber, reclaimed rubber, celluloid, cellulose esters. Illustrated. P. Saurel. *Revue gen. matieres plastiques*, Feb., pp. 108-14.

Rust-Proof Coatings. Iron and asphalt paints. Raw materials for protective coatings on metal; natural and artificial asphalts and cheaper substitutes. Recipes are given for rust-proofing paints and varnishes for Fe and for Al. E. O. Rasser. *Kunststoffe*, March, 1926, p. 49-53.

Government Publications

Prices indicated are charged by Superintendent of Documents, Washington, D. C., for pamphlets. Send cash or money order; stamps and personal checks not accepted.

Potash, Significance of Foreign Control and Economic Need of Domestic Development, by H. M. Boar. Bureau of Foreign and Domestic Commerce

Trade Promotion Series No. 33. 15 cents.

Ice-Making and Cold-Storage Plants in Continental Europe. Bureau of Foreign and Domestic Commerce Trade Information Bulletin No. 388. 10 cents.

Foreign Trade of the United States in the Calendar Year 1925. Bureau of Foreign and Domestic Commerce Trade Information Bulletin No. 387.

A Method for Testing Gas Appliances to Determine their Safety from Producing Carbon Monoxide, by E. R. Weaver, J. H. Eiseman and G. B. Shawn. Bureau of Standards Technologic Paper 304. 10 cents.

Relations Between the Temperatures, Pressures, and Densities of Gases. Bureau of Standards Circular 279. Price 25 cents.

The Technology of the Manufacture of Gypsum Products. Bureau of Standards Circular 281. 30 cents.

Temperature Corrections to Readings of Baumé Hydrometers, Bureau of Standards Baumé Scale for Sugar Solutions (Standard at 20 deg. C.). Bureau of Standards Circular 295. Price 5 cents.

Government Master Specification for Varnish Shellac. Bureau of Standards Circular 303. 5 cents.

Simplified Practice Recommendation No. 32—Concrete Building Units (Block, Tile, and Brick). Bureau of Standards pamphlet. 5 cents.

Simplified Practice Recommendation No. 38—Sand-Line Brick. Bureau of Standards pamphlet. 5 cents.

Federal Oil Conservation Board. Complete Record of Public Hearings February 10 and 11, 1926. 25 cents.

The effect of Smelter Fumes upon the Livestock Industry in the Northwest, by Robert J. Formad. Bureau of Animal Industry pamphlet.

Dust Control in Grain Elevators, by Hylton R. Brown and J. O. Reed. Department of Agriculture Bulletin 1373. 10 cents.

Carbon Monoxide Recorder and Alarm, by S. H. Katz, D. A. Reynolds, H. W. Frevert and J. J. Bloomfield. Bureau of Mines Technical Paper 355. 10 cents.

Possibilities for Commercial Utilization of Peat, by W. W. Odell and O. P. Hood. Bureau of Mines Bulletin 253. 35 cents.

Explosion Hazards from the Use of Pulverized Coal at Industrial Plants, by L. D. Tracy. Bureau of Mines Bulletin 242. 25 cents.

Sampling and Examination of Mine Gases and Natural Gas, by George A. Burrell and Frank M. Seibert, revised by G. W. Jones. Bureau of Mines Bulletin 197. 25 cents.

Analyses of Virginia Coals. Bureau of Mines Technical Paper 365. 10 cents.

Analyses of Missouri Coals. Bureau of Mines Technical Paper 366. 10 cents.

Methods of Analyzing Coal and Coke, by F. M. Stanton and A. C. Fieldner, revised by W. A. Selvig. Bureau of Mines Technical Paper 8. 10 cents.

Mineral Statistics: 1924 production figures have been issued by the Bureau of Mines in the following printed pamphlets: Antimony, by Frank C. Schrader; Lead, by C. E. Siebenthal and A. Stoll; Silica, by Frank J. Katz; Fuel Briquettes, by W. F. McKenney. 5 cents each.

Minerals Statistics: 1925 production figures have been issued by the Bureau of Mines in mimeographed press statements; as follows: The Chromite Situation; The Fluorspar Industry; Production of Aluminum; Production of Sulphur; Zinc Pigments and Salts; Preliminary Report on Quicksilver.

Solubility and Effects of Natural Gas and Air in Crude Oils, by D. B. Dow and L. P. Calkin. Bureau of Mines Serial No. 2732.

Experiences with the Combustion of Fuel Oil in Power Plant Boilers, by J. F. Barkley. Bureau of Mines Serial No. 2730.

The Gasoline Situation, by H. H. Hill. Bureau of Mines Serial No. 6003.

The Value of Leakage Tests on Natural-Gas Transmission Lines, by E. L. Rawlins. Bureau of Mines Serial No. 2735.

Pig Iron—Costs of Production. Preliminary statement of information obtained in the pending investigation by the United States Tariff Commission.

Miscellaneous Publications

The Bureau of Standards—Its History, Activities and Organization, by Gustavus A. Weber. Service Monographs of the U. S. Government No. 35, Institute for Government Research, Washington, D. C. Price cloth \$2.00.

Nickel Electrotyping Solutions, by William Blum and J. H. Winkler, for International Assoc. of Electrotypers. Available from Bureau of Standards, Washington, D. C.

Trade Standards adopted by The Compressed Air Society. (Second Edition) C. H. Rohrbach, Secretary, 90 West St., New York City.

Bituminous Coal Fields of Pennsylvania—Coal Analyses by the Bureau of Mines. Pennsylvania Topographic and Geologic Survey, Bulletin M 6, Part IV, 1925, Harrisburg, Pa.

Corrosion of Non-Ferrous Screen Wire Cloth

Committee D-14 on Screen Wire Cloth of the American Society for Testing Materials has for some time been investigating the corrosion of various types of non-ferrous screen cloths. In this investigation, seven different compositions, namely, 90 copper, 10 zinc; 80 copper, 20 zinc; 75 copper, 20 nickel, 5 zinc; 70 nickel, 30 copper, unalloyed copper; 98 copper, 2 tin; 95 copper, 5 aluminum; were to be exposed at four locations, at the Bureau of Mines at Pittsburgh, where there is a typical bad atmosphere; at the Portsmouth, Va., Lighthouse, which represents a normal seacoast atmosphere; at the Panama Canal, where the atmosphere is that of a tropical seacoast; and at the Bureau of Standards, Washington, D. C., representing a normal inland atmosphere. At a meeting of the committee held in Providence on March 18, it was reported that the test specimens had all been installed, laboratory tests had been made at the Bureau of Standards on the material exposed and the chemical and physical properties of the various specimens reported. The results of these tests will be given in the next annual report of the committee.

Protective Coatings for Structural Materials

At the fifth group meeting of the committees of the American Society for Testing Materials, held in Providence, R. I., March 17, 18 and 19, Committee D-1 on Preservative Coatings for Structural Materials discussed, among other problems, the accelerated weathering of paints and means of designating the color of paint materials. Accelerated weathering involves exposing painted surfaces to artificial weathering agencies such as light, moisture, freezing and thawing, and gases equivalent to the coal gas emitted from factory and household chimneys.

The study on the color of paints includes (1) recording color in such terms as to describe the total visual effect upon the eye, (2) having these records in such units as to be easily transmitted, and (3) in such form as to be readily reproduced. The first has been accomplished by means of the spectro-photometric curve which is readily transmittable in terms of hue, saturation and value. For the first time in the history of color, it has been possible to reproduce in paint form a color the physical attributes of which were represented only as a spectro-photometric curve. In other words, the committee has found it possible to reproduce a color that was an exact match to a color they had never seen. This marks a new phase in paint research which heretofore had always been declared impossible.

Work has been carried out on the development of an instrument whereby the drying time of varnishes will be determined which will eliminate all errors due to the personal equation. The room in which the determination is made, however, must needs be controlled as to temperature and humidity. A method of determining elasticity or toughness of less elastic varnishes is now available.

Possibly the most significant development in the paint and varnish industry in recent years is that of the new type of lacquers that are now becoming so popular for automobiles, furniture and other articles. These lacquers are receiving the attention of the committee as there are many technical problems that invariably attend a new development in industry that require consideration. The durability and quality of lacquers, contrary to general impression, exhibit the same variations in quality as do the old paints and varnishes and must be studied accordingly.

Behavior of Synthetic Tannins Toward Hide Substance

During the past 10 years or more, certain synthetic tanning materials, obtained chiefly by the interaction of some of the components of coal tar with sulphuric acid and formaldehyde, have come into use along with the usual vegetable tanning materials.

The Bureau of Standards, Department of Commerce, has been investigating the action of these so-called syntans on the hide during the tanning process and has just issued Technologic Paper, No. 309 on this subject.

The Plant Notebook

An Exchange for Operating Men

Handling Cars from Drier To Kiln

At the Birmingham plant of the Southern Clay Manufacturing Co. it was necessary to provide some form of transportation by alternating current for transferring loaded larry cars from the drying ovens to the kilns. The problem was solved by designing a transfer car to carry one larry car weighing approximately 2900 lb. when loaded.

Power is supplied from three overhead trolleys connected to the 220 volt, 3 phase source. The driving motor is a G. E. 5 horsepower, 900 r.p.m., 3 phase, 60 cycle, 220 volt machine, and a duplicate motor is mounted on the car driving a winch used to pull the larry cars on and off the transfer platform.

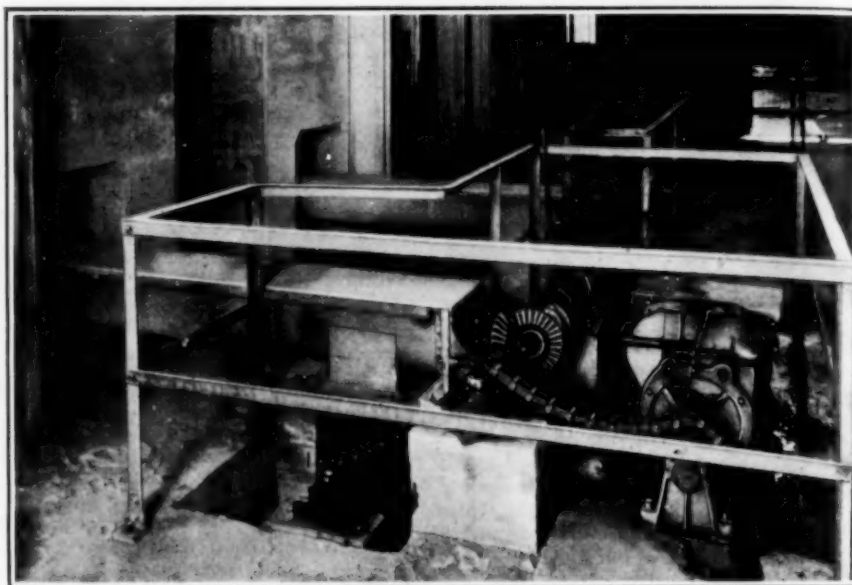
Control is provided by a G. E. drum controller and resistor. An arrangement of two triple pole, double thrown, fused, knife switches provides for transferring the control from one motor to the other. These switches are mounted on the back of the bench. The control regulates the driving motor while moving the car. It is then switched over to the winch motor which pulls a loaded larry on the transfer platform, and then it is switched back to the driving motor. A satisfactory and economical control for the transfer car is thus provided.

Special Conveyor Designed For Hot Materials

When conveyors must handle hot materials such as cement clinker special provision must be made in the design to take care of expansion and the support of the shafts and flights must be unusually rigid to avoid warping.

An illustration of this is found in the installation of screw conveyors installed in the plant of the Standard Portland Cement Co., Painesville, Ohio. These 4 Stearns screw conveyors handle clinker at 1,500 deg. F. direct from the kilns. Three of them are 60 ft. long and the fourth is 65 ft. long. These conveyors discharge into a cross conveyor of the same type which conveys the clinker to the cooler. All 5 conveyors are driven from the same motor, the cross conveyor by means of a speed reducer and chain and the 4 parallel conveyors from a countershaft through bevel gears. Each of the latter 4 is equipped with a jaw clutch cast integrally with its bevel gear so that it can be started or stopped independently of the others.

The cross conveyor runs in a concrete trough built into the floor. This makes it possible to anchor the countershaft and by making the end bearings of the 4 parallel conveyors integral



Special Design of Conveyors for Handling Hot Cement Clinker

with those of the countershaft, the drive ends of these conveyors are also anchored firmly in permanent alignment. The other conveyor troughs are made from $\frac{1}{8}$ in. steel plates. All conveyor screws are 10 in. in diameter and $\frac{3}{4}$ in. thick made from steel plates. The feet of the steel troughs are made of cast iron, riveted to the troughs and set on $\frac{1}{2}$ in. steel bearing plates, anchored to concrete piers. Cast iron guides on these plates permit the troughs to slide when expansion or contraction occurs, and yet maintain alignment. In order to allow for the heat expansion of the screw, the screw itself is cut back 3 in. from the hangers. The total expansion allowed for is $2\frac{1}{2}$ in. on the troughs and 5 in. on the screw.

All hanger bearings are made of chilled iron. Main shaft bearings are bronze bushed. Troughs are covered with a steel plate, flanged over at the edges by means of angles riveted on and extending into the troughs. Sand seals are used to prevent dust from escaping.

Condenser for Experimenting On Semi-Plant Scale

By E. Y. Wolford

University of Pittsburgh, Pittsburgh, Pa.

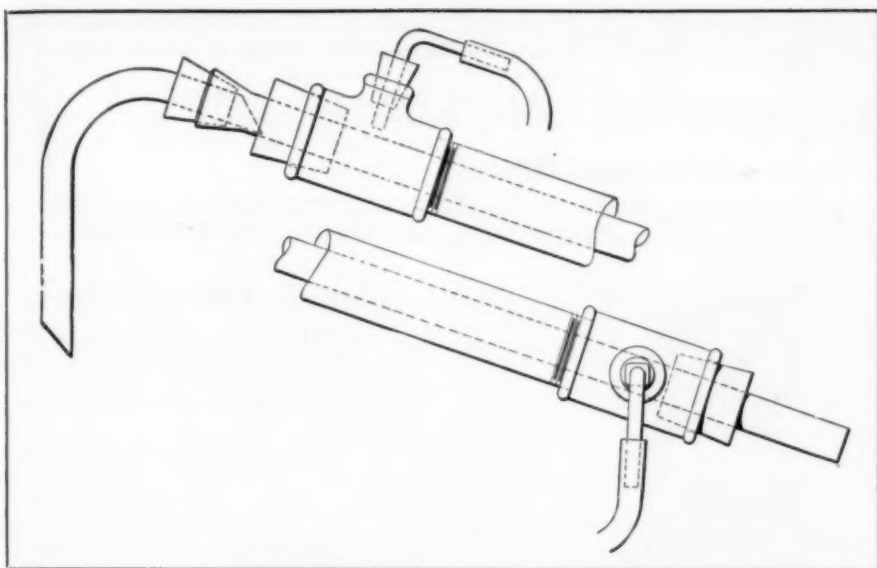
The condenser here described and illustrated has been found to be a convenient form of apparatus, particularly in the semi-plant development of processes. It is made of parts, most of which can usually be obtained easily about a plant. While intended primarily for bench work it has a considerable capacity. It is far less breakable than the usual glass con-

densers and so can be subjected to more severe handling.

It consists of a shell of 14-in. iron pipe, about 19 in. long, threaded at each end to take two $1\frac{1}{4}$ x $\frac{1}{2}$ -in. reducing tees. Two straight 14-in. tees may be used, but larger corks or plugs are required for the water inlet and outlet. The condensing tube proper consists of a $\frac{3}{4}$ in. outside diameter copper or aluminum tube. Aluminum tube is suggested because it does not discolor the distillate as is so frequently the case with copper. One end of the tube is flared out, for an inch and a quarter, until the inside diameter of the lip is $\frac{1}{4}$ in. (aluminum requires careful handling here), so that a No. 10 cork will fit. The cork carries a glass or metal gooseneck, $\frac{1}{8}$ to $\frac{3}{8}$ in. outside diameter beveled at both ends, to prevent binding of the vapors by condensate. The gooseneck connects the condenser head with the flask or metal boiler in which the substance to be distilled is vaporized, and a larger diameter can be used when the condenser tube is flared, giving greater capacity. The gooseneck should carry well down into the tube.

A 3-in. hole is bored in a No. 20 cork, which is then slipped into the condenser tube and pushed (wetting helps) nearly up to the flare in the tube as shown in the illustration. The tube is then placed inside the assembled shell and the cork is screwed into the upper tee. This not only makes a tight joint between the tee and cork but also squeezes the cork down tightly on the condenser tube. The condenser tube now protrudes 3 to 4 in. out of the opposite end of the shell and another No. 20 cork is bored, slipped on the tube and screwed into the bottom tee.

For the water inlet and outlet, a



Condenser for Semi-Plant Scale Development

piece of quarter inch copper tube conveniently bent (see illustration) is pushed into a No. 6 cork, bored to take it. Then the cork is screwed into the $\frac{1}{2}$ -in. outlet of the tee. Or if two $\frac{1}{2}$ -in. brass plugs are at hand, these may be bored and the copper pipe soldered or brazed into them after which the plugs are screwed into the tees. In the illustration, the water connection to the top tee is shown with a cork, the lower one with a plug. Water is lead to and from the condenser by the usual laboratory rubber tubing.

The ordinary glass laboratory condenser having a constriction at the head and also at the lower end, always holds a small quantity of liquid of one fraction at these places, which contaminates the next fraction. The condenser illustrated is free from this defect. Its substantial construction from parts that can be conveniently procured should appeal to practical workers and as to its capacity, it has been found that the vapors cool so rapidly in the metal tube that a small stream of distillate (particularly in vacuum or steam distillations) can be kept running from it, so that 8 to 15 lb. of distillate can be collected in an hour.

Simple Method for Painting Fine Mesh Screens

By Paul Stegeman
Midland, Mich.

Some time ago it was necessary for us to paint about a dozen rolls of rather fine mesh screen with a special acid resisting, tar-base paint. The paint was dissolved in an organic solvent and we first tried to apply it by dipping the screen into a trough in which the paint was poured. The consistency was such that the meshes were filled with a film of the paint and it dried very rapidly due to the large surface exposed and left the screen in such shape that it could not be used. We then tried painting it by hand but this was both slow and otherwise unsatisfactory as only one side could be painted at a time and it was very difficult to apply a uniform coat which did not fill at least some of the meshes.

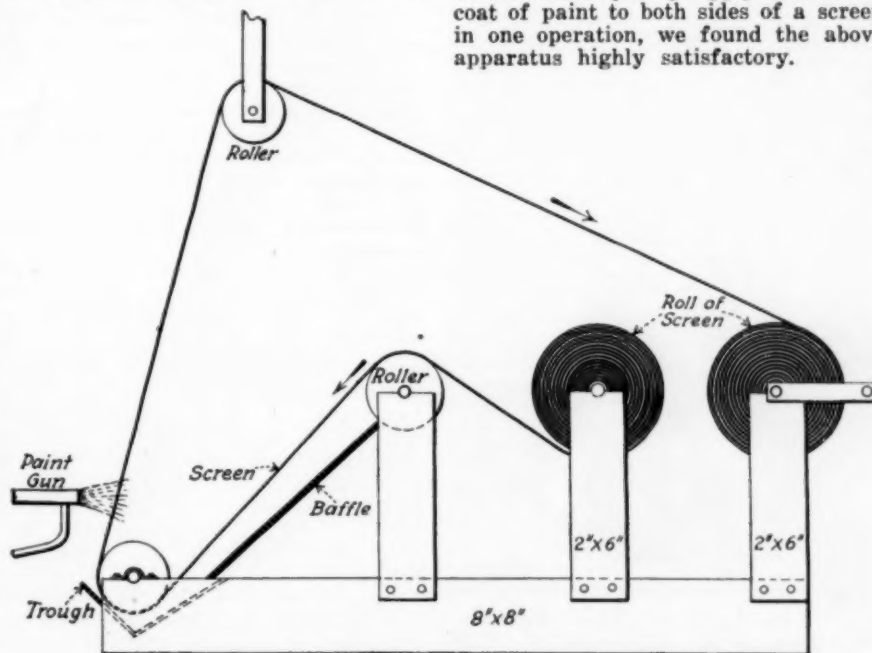
We finally rigged up the apparatus here sketched from some scrap lumber lying about the plant and found that it worked so satisfactorily that the job was done in a short time. The materials used were two 8x8. in timbers, six 2x6 in. timbers, 3 rollers, four inches in diameter, two half inch rollers one of which was fitted with a hand crank, and one wooden trough to catch the excess paint. As illustrated, the roll of screen was put on one of the small rollers, placed in a notch in the middle support, and a wire threaded over and under the rollers as shown, fastened at one end to the screen and at the other end to the roller at the rear of the machine. The crank was then turned and the screen drawn over the rolls and the paint applied as it passed the lower roller.

The paint was applied with a paint gun which we made up out of a $\frac{3}{4}$ in. pipe tee bushed down to $\frac{1}{4}$ in. in one of the openings. The air hose was coupled to one end of the tee and the current of air passing through acted as a jet,

drew the paint up through the $\frac{1}{4}$ line and atomized it into a fine fog, which coming in contact with the mesh of the screen coated it with a very uniform coat of paint which we found much more satisfactory than any we had been able to apply heretofore. We found that we could apply a coat of any desired thickness by regulating the air and the diameter of the paint opening in the gun and the meshes were not plugged up because the air from the gun broke the film between the meshes and dried it at the same time so that the screen was dried and ready for use by the time it was rolled up on the rear roller.

A rather unexpected point we found, however, was that the paint could be thinned down to the point where it was fluid enough so that part of it was blown through the first screen and striking the opposite side of the same screen just ahead of the baffle plate would put on a coat on the reverse side, in every way quite as satisfactory as that applied immediately at the mouth of the spray gun. Any extra paint, blown through the second screen found its way into the trough at the bottom of the machine, underneath the lower roller. As one reel of screen was finished the start of the next roll was hooked to the end of the previous one, obviating rethreading.

Two men were required to operate the machine, one to turn the crank and the other to operate the gun. I believe I am not exaggerating when I say that they were able to paint at least ten times as much screen and do it much more uniformly and with less effort than if it were done by hand. The cost of the apparatus was practically nothing beyond the time of the mechanic required to put it together, and most of the lumber was used for other purposes afterwards. At first we rather expected to fill the room with a fog of paint but there was surprisingly little paint wasted as most of it stuck to the screen, even when largely diluted. As a home made apparatus, which would quickly apply a uniform coat of paint to both sides of a screen in one operation, we found the above apparatus highly satisfactory.



Sketch of Layout of Simple Method for Painting Fine Mesh Screens

Equipment News

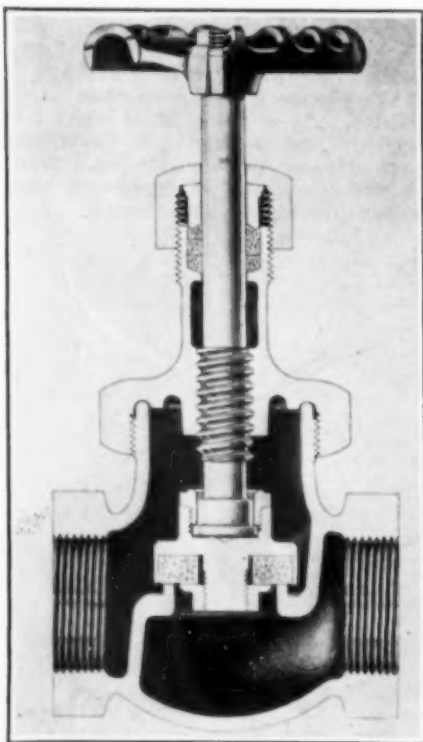
From Maker and User

Globe and Angle Valves

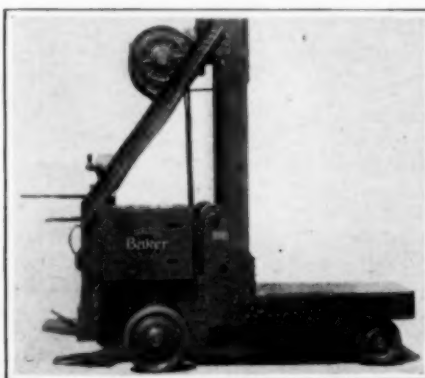
Jenkins Bros., 80 White St., New York City, have placed on the market improved types of globe and angle valves for pressures up to 225 lb. working steam pressure. These types have the renewable disk feature found in Jenkins standard valves.

A feature of the valves is the "ball" joint formed when the bonnet and body are screwed together. This is a new design and is said to make a strong but easily removable joint. The bonnet and union are made in one piece to screw on outside body threads. This is to give extra strength to the body end, the bonnet hexagons being made especially large to allow easy removal of the bonnet without distortion.

Disks of a special composition for high pressure work are used. This avoids the necessity of regrinding to keep the valve tight. The spindle is made of manganese bronze, with large threads that are all in contact when the valve is closed. The stuffing box is designed to allow plenty of room for the asbestos packing, which is compressed by means of a bronze follower or gland. A ventilated hand wheel of malleable iron is furnished. These valves, globe or angle, screwed or flanged ends, come in sizes from $\frac{1}{4}$ to 3 in.



Cross-section of Globe Valve
This design is for pressures up to 225 lb. working steam pressure and embodies the renewable disk feature found in standard valves



Six-Ton High Lift Truck

This unusually sturdy truck is built for lifting and stacking heavy loads in tiers.

High Lift Truck

The Baker-Raulang Co., Cleveland, Ohio, have brought out a 6-ton model of their "Hylift" truck, designed for handling the extremely heavy service met with in some industries. This truck embodies the design features found in other models of Baker trucks except that it is made unusually sturdy to handle heavy loads, as for instance, 8-in. specially rolled nickel steel I-beams are used for the vertical track upon which the roller carriage runs.

Gasoline Locomotive

The Vulcan Iron Works, Wilkes-Barre, Pa., has added a 12 ton model to its line of worm gear drive gasoline locomotives, to be known as Class EW-12. This locomotive is similar in general design and construction to the other worm drive machines made by this company.

Equipment of the new model includes a 100 hp. Waukesha motor with Ricardo head. There are 4 speeds forward and 4 reverse, ranging from 2 3/10 miles per hour in low gear up to 12 in high. Drawbar pull in high is 2,275 lb., with a starting pull in low of 7,200 lb.

Micarta Timing Gears

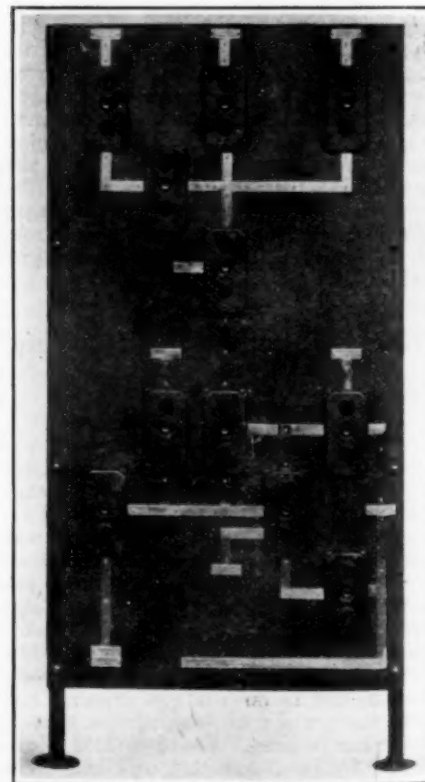
In manufacturing timing gears for internal combustion engines, the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., have developed a new design and method of construction. This consists in forming the rim in which the teeth are cut of a multiplicity of short segments each about 1 in. in length, making 18 or 20 segments to a 6 in. blank in place of the 4 segments formerly used. In addition, the new design embodies a thin pressed steel web affording a greater degree of lateral flexibility for gear tooth alignment than is obtained in either the all-composition or the cast iron center types.

Electric Valve Control

A unique remote control panel for steam line valves is shown by the accompanying illustration. This panel is the design of the General Electric Co., Schenectady, N. Y.

The mimic buses and nameplates shown on the black panel are of polished copper. The buses represent steam lines and the nameplates are engraved with the size of pipe to a particular boiler, size of pipe to a particular turbine unit or the location of valves. The pushbutton stations are used only to close valves, each being in parallel with the closing buttons of another pushbutton station. The "open" control is located at this last pushbutton station.

Each group of pushbuttons has three buttons. The topmost button controls the valve which feeds a high pressure steam line to a unit, the lowest button controls the valve feeding low pressure steam to the same unit and the middle button is a master by means of which each of the two valves can be closed. As the two valves in question are of steam lines of different pressure, both cannot be open at the same time, one always being closed. The



Remote Control Panel for Valves
The push buttons on this panel are only for closing valves. Opening and closing also is done by other push button controls located conveniently for each valve controlled.

master pushbutton, when depressed, will close the open valve, no matter which one it may be. By noting the red indicating lamps which are lit it is possible, with this panel, to trace any open steam line from the boiler to the turbine unit.

Steam Generator of Novel Design

A new boiler for the generation of steam for power plants, called the "Combustion Steam Generator" has been brought out by the Combustion Engineering Co., 43 Broad St., New York City.

This device operates upon an entirely different scheme from that of the usual steam boiler. It is well known that, in a boiler, the lower row of tubes, exposed to the radiant heat of the fire and the heating surface included in the first pass, do a very large part of the total work. In this new design this fact is taken advantage of. Practically all of the boiler heating surface is exposed to radiant heat. The use of pulverized fuel firing makes it possible to omit a large furnace with refractory surfaces, water screens, side wall screens and other accessories such as are required by many other modern installations of boilers.

As can be seen from the illustrations, which show a side sectional elevation and a section in plan through the furnace, the unit consists of a furnace the walls of which are composed of tubes of the fin type, all exposed to radiant heat. Pulverized coal is introduced through burners located in the four corners of the furnace and burned in a turbulent condition in the form of a vortex, since the primary mixture of fuel and air as well as the highly preheated secondary air enter tangentially to an imaginary circle as is shown by the broken lines in Fig. 2.

From the furnace, the flame and hot gases descend through a multitubular water screen into a settling chamber wherein the ash is deposited and from there the gases flow upward through a superheater and an air preheater to the stack or induced draft unit, as the case may be.

Circulation in this generator follows

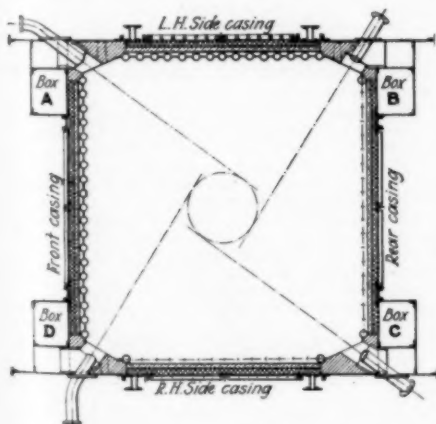


Fig. 2—Section Plan of Combustion Chamber of New Steam Generator

It is said that this unit gave an efficiency of 88 per cent when evaporating 70,000 lb., equivalent to about 1,200 per cent of rating.

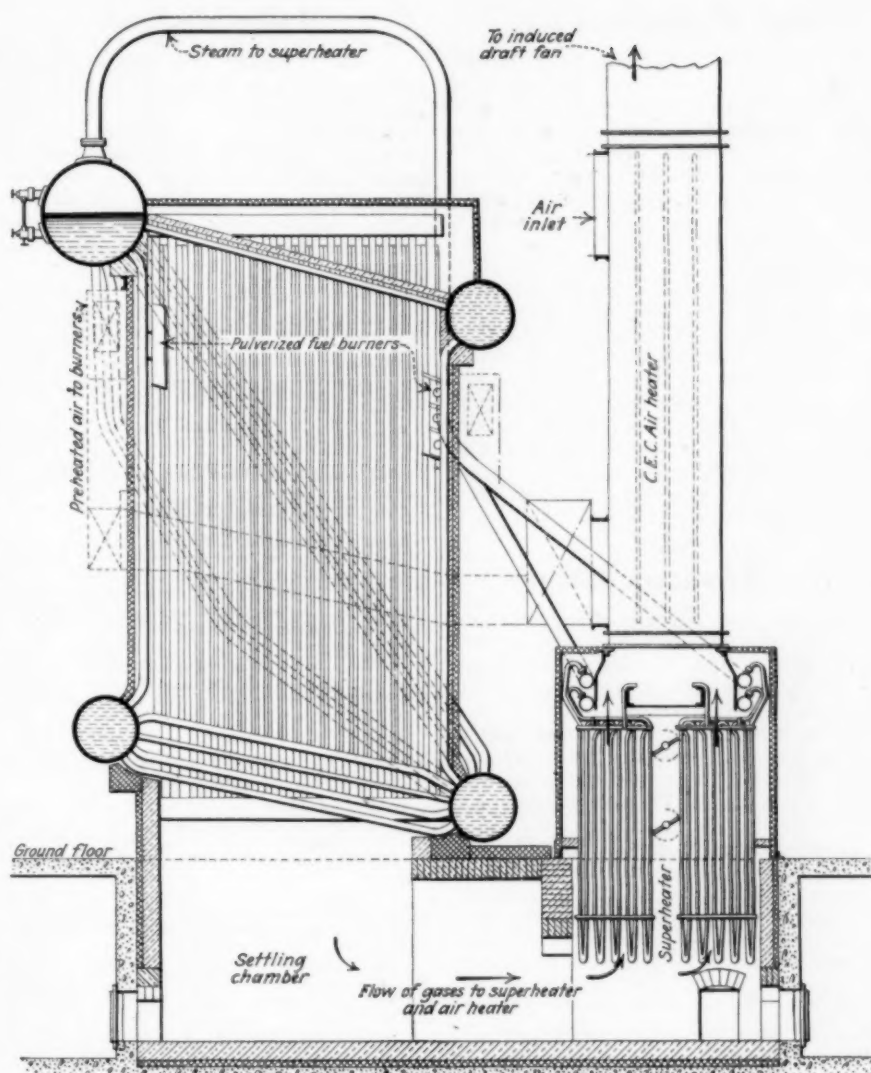


Fig. 1—Side Sectional Elevation of New Steam Generator

This unit has a superheater and air preheater installed as part of the unit. It burns pulverized coal and has all the heating surface exposed to direct radiation

a definite path. Water is fed to the main drum, shown in the upper left of Fig. 1. It passes through outside tubes, shown by broken lines, to the lower right hand drum. From this drum it passes through the vertical fin tubes forming one wall of the combustion chamber to the drum at the upper right and thence through tubes forming the roof of the chamber to the main drum. Water also passes through the tubes forming the lower water screen to the drum on the lower left and thence through vertical fin tubes to the main drum. The lower horizontal headers for the fin tubes of the other two walls are also connected to the lowermost drum and the upper horizontal headers of the same tubes are connected to the main drum.

Among the advantages claimed for this steam generator is the great saving in construction cost. It requires from $\frac{1}{2}$ to $\frac{3}{4}$ the space of boiler units of equal capacity. Also it can be erected in much less time. In addition it is designed to realize the full economy of pulverized coal as a fuel. Other advantages are low cost of steam generation, simplicity, quick pick-up of load, minimum radiation loss and low draft loss.

Scavenging Compressor

One of the first installations in this country of an oil engine supplied with scavenging air from a separate, direct current, motor driven, centrifugal air compressor, is in the Trommers Brewery, Brooklyn, N. Y. The oil engine drives a generator and is of the Knudsen Diesel type.

The compressor is a General Electric machine, rated 1,400 cu.ft. per minute, 2½ lb. pressure, 3,500 r.p.m., and is driven by a 115 volt, d.c. motor. Scavenging air is furnished for the purpose of removing the foul gases from the cylinders of the oil engine, this work formerly being done by air supplied from an additional piston on the oil engine. By using the centrifugal compressor, a total reduction in weight of approximately 5 per cent and a 12 per cent reduction in length are effected. Smoothing out the pulsations in the supply of scavenging air is another advantage obtained by use of the centrifugal unit.

The discharge pressure is easily varied by adjusting the speed of the direct motor which drives the compressor. This is done by controlling the field of the motor.

News of the Industry

Customs Court Upholds Flexible Tariff

Test Case Brings Decision Sustaining Constitutionality of the Law

A decision was handed down by the United States Customs Court in New York on April 6, which held that the President acted within the legal rights of his office in increasing the rate of import duty on barium dioxide, according to the flexible provision of the Tariff act. The decision arose from an action brought against the United States by J. W. Hampton Jr. & Co., to test the powers of the President in changing the duty on barium dioxide imported by this company from Germany. The case attracted wide attention because it was regarded as a test to determine whether the flexible tariff provisions were constitutional.

In handing down a decision upholding the President's action, Judges McClelland and Sullivan stated:

"It is claimed by the importers (protestants in this proceeding) that the President's proclamation was and is unconstitutional and void because done under an illegal delegation to the executive department of the power to legislate in violation of Article 1 of the Federal Constitution, and further, because it was done in violation of Section 5 of said Constitution, which vests in the Congress of the United States alone the power to tax.

"Held (1) that the delegation by the Congress to the President of the powers expressed in Section 315 was not a delegation of legislative authority or of the power to tax in violation of Sections 1 and 8 of Article 1 of the Federal Constitution.

"(2) That the President in making such investigation and in determining the difference between the cost of production of barium dioxide in the United States and Germany, as well as fixing a rate of duty which would equal such difference, was but carrying out the expressed will of Congress and such action was therefore in no sense a usurpation of the constitutional privileges of that body."

Judge Brown in dissenting, said:

"Differences in production costs not being a definite fact which can be accurately ascertained, the so-called finding of such alleged cost differences must necessarily involve discretion, choice and judgment, and therefore Section 315 is an attempt to delegate the legislative trust and discretion committed by the people to Congress alone.

"If the majority conclusion is right, the Congress, by declaring a few general principles of taxation, can abdicate the substance of its legislative trust over that entire subject, and pass its representative responsibility over this power to destroy to bureaus and commissions (fortified by Presidential proclamation) thus leaving the people, their business and their property entirely at their mercy and necessarily without court review of their taxing discretion."

F. W. Robinson Retires From Chemical Catalog Co.

Edward G. Nellis and Ralph Reinhold have acquired the interests of F. W. Robinson in the Chemical Catalog Co., Inc. Mr. Robinson has been president and a director of this company since its organization in 1916. He is retiring to devote his attention to other interests outside the publishing field. Mr. Nellis, heretofore vice-president, succeeds Mr. Robinson as president. Francis M. Turner, Jr., for the past ten years technical editor of the company, has been elected vice-president and a director. Mr. Reinhold continues as treasurer and director, which offices he has held since the company was established.

British and Scotch Dye Makers in Merger

An arrangement has been completed between the British Dyestuffs Corporation, Limited, and Scottish Dyes, Limited, whereby the former acquires a majority financial interest in the Scottish company, according to consular advices to the Department of Commerce.

The two companies are reported to have entered into an agreement by which Scottish Dyes will remain an entirely separate company under the same management as now, with James Morton as chairman, and Dr. Thomas as managing director. Sir William Pope, who has acted for several years as technical adviser to Scottish Dyes, has been appointed a director.

The new arrangement is said to have been made in order to concentrate manufacture, thereby effecting substantial reductions in costs of the vat colors which in the future will be produced exclusively by Scottish Dyes at its works at Grangemouth, where considerable extensions will be made immediately.

A. S. T. M. Committees Meet in Providence

Thirteen committees of the American Society for Testing Materials took part in the fifth group meeting held at the Providence Biltmore Hotel, Providence, R. I., on Wednesday, Thursday and Friday, March 17, 18 and 19. The committees were as follows: A-1 on Steel, A-2 on Wrought Iron, A-5 on Corrosion of Iron and Steel, B-1 on Copper Wire, B-2 on Non-Ferrous Metals and Alloys, D-1 on Preservative Coatings for Structural Materials, D-9 on Electrical Insulating Materials, D-11 on Rubber Products, D-13 on Textile Materials, D-14 on Screen Wire Cloth, and Section, E-1 on Tests of Thin Sheet Metals.

In addition, meetings were held of the Joint Research Committee of the A. S. T. M. and of the A. S. M. E. on the Effect of Temperature on the Properties of Metals, and of the Joint Committee on Effect of Phosphorus and Sulphur in Steel. The meetings were attended by about 350 members and guests representing iron and steel non-ferrous metals, rubber products, textile materials, electrical industries, railroads, public utilities, government bureaus and the technical press.

Government Color Requirement for Gasoline Withdrawn

The official color requirement for United States Government motor gasoline has been deleted from standard specifications by the executive committee of the Federal Specifications Board as the result of a recommendation by the United States Public Health Service that all gasoline containing tetraethyl-lead should be given a distinctive color as a safety precaution. Several states have enacted legislation making the current U. S. Government specification for gasoline official in the state, and making revisions of the Government specification apply also in the local specification. For this reason it was necessary to reconcile the Surgeon General's recommendations with the specifications, and since it has been the opinion of many people for some time that the color requirement could be replaced by a more suitable one, the action of the executive committee of the Federal Specifications Board was taken upon the recommendation of the Technical Committee for Lubricants and Liquid Fuels. This latter committee is composed of technical representatives of the government departments which use petroleum products.

Petroleum the Main Theme at A. C. S. Tulsa Meeting

Fiftieth Anniversary Meeting Will Be Held in Philadelphia in September

Petroleum technology proved the main theme of the seventy-first meeting of the American Chemical Society held in Tulsa, Oklahoma, April 5 to 9. A predominant proportion of the 500 registrants was drawn from the oil industry of the Midcontinent field and it was therefore natural that most interest should attach to the symposium on lubrication, the several sessions of the petroleum division, and the excursions to nearby oil fields, refineries, and gasoline plants.

At the council meeting in which most of the society's business is transacted, discussion centered around the plans for the fiftieth anniversary meeting to be held next September in Philadelphia, at the time of the Sesqui-Centennial Exposition. The chemists of the world will be officially invited to this meeting which will take on an international character because of the large number of foreign scientists who are expected to be in this country at that time. The Spring meeting in 1927 will be in Richmond, Va., and the Fall meeting next year in Detroit. The Council selected St. Louis as its meeting place for April, 1928. At the same time acknowledging invitations from the sections at Boston, Toronto, Chicago, and Cincinnati.

Prof. S. W. Parr urged the appointment of a committee on chemical engineering education on the ground that the viewpoint of the American Chemical Society is needed in the work now being done by other agencies in encouraging the proper training for chemical engineers. As instructed by the vote of the council, President James F. Norris will shortly appoint a committee of five members representing both the universities and the industries that employ men of chemical engineering training.

Honorary membership was unanimously tendered to fourteen chemists, of whom three are Americans, one a Canadian, two are Frenchmen and the others represent England, Scotland, Italy, Holland, Czechoslovakia, Switzerland, Japan, and Belgium. The new honorary members are Ira Remsen of Johns Hopkins University, Theodore W. Richards of Harvard University, Edgar Fahs Smith of the University of Pennsylvania, W. Lash Miller of the University of Toronto, Charles Moureaux of the College of France, Paul Sabatier of Toulouse, Bohuslav Brauner of the University of Prague, Giuseppe Bruni of the University of Milan, Ernest Cohen of the University of Amsterdam, Frederick G. Donnan of the University of London, Sir James C. Irvine of the University of St. Andrews, Joji Sakurai of the University of Japan, and Frederic Swarts of the University of Belgium.

The Priestley medal, the highest honor to be conferred by the society, was awarded to Edgar Fahs Smith.

The paper to arouse the most scientific interest was that of Prof. B. S. Hopkins of the University of Illinois in which he made public for the first time

the detailed account of his research with J. Allen Harris and Leonard F. Yntema, which led to the discovery and identification of the new element for which he proposes the name "illinium." The public address of Dr. Arthur D. Little on the "Romance of Carbon" also proved a popular attraction.

The lubrication symposium held under the chairmanship of R. E. Wilson, and the Senate of Chemical Education preceded the divisional meetings. Of the latter the Petroleum Division drew the largest attendance in its history, probably exceeding in this respect any meeting ever held of petroleum chemists and engineers. Agriculture and food chemistry with a symposium on cotton products and vegetable oils led by Dr. David Wesson was of interest to many. Other divisions to hold sessions included gas and fuel, organic and physical and inorganic chemistry. In addition to its technical meetings the Water, Sewage and Sanitation Division arranged a trip to Lake Spavinaw, which furnishes the water supply of Tulsa.

The oil refineries of the district visited during the society excursions included those of the Midcontinent Petroleum Corporation, Producers and Refiners Corporation, The Texas Co., and The Pierce Oil Corporation. Longer excursions also provided an opportunity to see the oil fields at Jenks, Kiefer and Glenpool and to inspect several gasoline plants operated in this vicinity.

Research in Fundamental Science Planned

The ablest and most effective investigators in pure science in the United States will be selected by the National Academy of Sciences to conduct research in fundamental science, if a plan now under way to obtain immediate support for this pressing national need is successful.

An outline of the purposes of the undertaking, made public by a special board of trustees, which has been appointed by the National Academy, with Herbert Hoover as chairman, to secure immediate financial aid for pure science research, indicates that it is hoped to be able to make such provision that the most skilled scientific investigators will be able to work solely to the end that there will be an increase and strengthening of American contributions to the mathematical, physical and biological sciences.

Government Bureaus Engaged in Research on Lubrication

The Bureau of Standards and the Bureau of Mines are engaged in fundamental research respecting lubrication and have outlined additional projects relating to this subject. In addition to the usual specified tests, oils are subjected to the following tests: (1) measurement of dilution; (2) measurement and comparable analysis of ash with determination of metallic content; (3) vacuum distillation of oils; (4) carbon formation in engine cylinder with analysis of same; (5) oxidation test of oils.

Casein and Linseed Oil Tariff Reports Made Public

Unpublished reports which the Tariff Commission has submitted the President in flexible tariff investigations affecting two items of the chemical schedule, casein and linseed oil, have been made public as the result of subpoenas issued to the commission by the special Senate committee which is investigating the activities of that agency.

The casein report shows that the entire commission joined in a recommendation that there be no change in duty owing to the impossibility of comparing costs of production in the United States and in Argentina, the principal competing country, but Commissioner E. T. Costigan signed a separate statement disagreeing with some of the reasoning of the majority members. The application in this case was filed by manufacturers of coated paper, who asked a reduction in duty. The case was opposed by domestic dairy interests. The commission sent investigators to the Argentine twice in an effort to get costs of production, but the differences in handling milk between the two countries made comparisons of casein costs impossible. The President had concurred in the recommendation that no action be taken, under the circumstances.

The linseed oil report is in three sections. This case was undertaken as the result of an application by the Bureau of Raw Materials, representing paint and varnish manufacturers, for a lower duty. The report was sent the President more than a year ago, but recently was returned to the commission by the executive with a request for further data in regard to flaxseed production in the United States, which data have not yet been completed. It is the original report which has been submitted the Senate committee. All six commissioners signed the factual section of the original report and all agreed that there should be a reduction in duty to equalize costs of production between the United States and Great Britain, but they differed as to the extent of the reduction necessary. The existing duty is 3.3c. per lb. Commissioners Marvin, Burgess and Glassie reported that the difference is 2.7c. per lb., which would mean a reduction of 6c. per lb. in order to equalize costs. Commissioners Culbertson and Costigan reported the difference as 2.44c. per lb., which would call for a reduction of 86c. per lb. to equalize costs, while Commissioner Lewis reported the difference as 2.43c. per lb., which would necessitate a reduction of duty of .87c. per lb. to equalize costs.

Caustic Soda Will Be Produced in Colombia

A report to the Department of Commerce states that industrial chemicals will be produced in a plant which was recently established at Bogota. According to present plans the new company will first manufacture caustic soda, liquid chlorine, quicklime hydrochloric acid, hydrogen peroxide and glycerine preparations. Heretofore, no industrial chemicals have been manufactured in Colombia.

Chlorine Symposium Feature of A. E. S. Convention

Various Phases of Chlorine Industry Will Be Discussed at Chicago Meeting

The American Electrochemical Society will hold its Annual Convention at the Chicago Beach Hotel, April 22, 23 and 24. The main attraction of the technical program is a symposium on chlorine. For a good many years there has been an over-production of chlorine in the electrolytic chlorine industry and manufacturers throughout the world are very much interested in finding new uses for the gas. The economic importance of the situation is reflected by the ready response that D. A. Pritchard, chairman of the symposium, has received from both the industries and the universities throughout the world.

Japan has contributed 4 papers to the symposium. Dr. S. Ochi, of the Tokyo Imperial Industrial Laboratory, summarizes the general situation of chlorine manufacture in Japan and also records details in the manufacture of bleaching powder. Another paper by Dr. Ochi covers the use of chlorine in the refining of sugar.

J. T. Conroy, of the United Alkali Co., Widnes, England, discusses the use of chlorine in organic chemical industry. Chairman Pritchard, works manager of the Canadian Salt Co., at Windsor, Ont., will present a paper dealing with the economics of chlorine and emphasizing that a productive capacity, related to consumption, and continuous research are necessary in order that the chlorine industry may be prosperous.

"The Chlorine Industry in America" is covered by a number of authors. "The Use and Importance of Chlorine in Chemical Warfare" is treated by Maj. General Amos A. Fries. "The Transportation of Liquid Chlorine Gas" is discussed at great length by Mr. H. P. Wells, technical director, Electro Bleaching Gas Co.; H. M. Mabey, general traffic manager, The Mathieson Alkali Wks., and J. M. Rowland, chief engineer, Hooker Electrochemical Co. The chlorination of metals as an industry which is gaining rapidly in importance is shown by Paul S. Brallier, chief chemist, Niagara Smelting Corp. Chlorine is used in the detinning of tin plate scrap, producing tin or tin salts, commercially valuable from a byproduct otherwise an economic loss. This subject has caught the attention of Chas. L. Mantell, of New York City, and in his paper he discusses the various commercial processes and the cost of operation.

Louis Burgess, of the Standard Oil Company, reports upon the latest advances made in the use of chlorine in the petroleum industry. At present aluminum chloride is employed in the production of gasoline. Furthermore, there are a large number of chloro derivatives of methane which are now produced directly by chlorination.

Besides the technical papers in the chlorine symposium, there will be a number of papers dealing in particular with the scientific aspects of the chemical and physical characteristics of chlorine. Dr. A. L. Marshall, of Princeton University, will present the results

of his researches on the "Photochemical Reaction Between Hydrogen and Chlorine." Another report of research, carried out at Columbia University, will be presented by Colin G. Fink and L. C. Pan, on "Insoluble Anodes for the Electrolysis of Brine."

On Friday morning the retiring president of the Society, F. M. Becket, vice-president of the Electrometallurgical Corp., will deliver an address on "Modern Requirements in the Education of an Engineer." Following this address, the meeting will be devoted to miscellaneous electrochemical papers.

Pyroxylin Lacquers in Demand in British Isles

A report from assistant trade commissioner W. M. Park shows that the growth in the use of pyroxylin lacquer in this country is finding a counterpart in the British Isles. This report says that the use of cellulose finishes for passenger cars and commercial vehicles in the British Isles is rapidly increasing. Until recently interest outside manufacturing circles has been confined mainly to the private car owner, but since the London Motor Transport Exhibition last autumn omnibus and coach proprietors have also investigated the merits of such finishes for their vehicles.

It is estimated that during 1925 about 25,000 to 30,000 gal. of cellulose finish were used in the British motor car industry, and that for the present year approximately 55,000 gal. will be used on passenger cars, 10,000 gal. on commercial vehicles, and 20,000 gal. in other general use, or a total of 85,000 gal. It is believed that the British market will take about three years to fully materialize in its use of this finish, at which time the consumption will be on the basis of about 200,000 gal. per annum for finishing, and the same amount for refinishing.

At present one large British firm produces about 50 per cent of all such lacquer used in Great Britain. There are several other British companies now manufacturing a similar product, but up to the present time their production has been relatively small. It is estimated that in future competition will be extremely keen in the manufacture and sale of cellulose finishes in the British market, but this concern expects to continue to hold the market for at least 50 per cent of the requirements.

Anglo-German Interests Form Chemical Combine

The International Pulp and Chemical Co., Ltd., has recently been formed with a capitalization of 1,000,000 pounds, according to a consular report to the Department of Commerce from London. The object of the company is to acquire shares of the Koholyte A. G., owning five freehold factories in Germany, of which two are large producers of chemical pulp. The other factories produce paper, electrolytic caustic soda, chlorine and other chemical products.

Research Graduate Fellowships at Wisconsin

For the purpose of promoting engineering research and the development of qualified research men, the University of Wisconsin has established three research fellowships in the College of Engineering. These fellowships are granted under the following conditions:

Each fellow will be appointed for a period of two years, subject to satisfactory service. The salary will be \$900 for the first year and \$1100 for the second year. The fellow will be required to devote not less than half his time to assigned research work in the College of Engineering, but will in any case be given opportunity to complete his work for the M. S. degree within the two-year period. Candidates must be graduates of engineering colleges of recognized standing, and should preferably have had one or two years graduate study or teaching or engineering experience. The period of service required will be the usual academic year, including the short vacations. The College of Engineering possesses well-equipped laboratories in which a considerable amount of research work is always under way. Results are published, from time to time, in bulletins of the Engineering Experiment Station. A total of sixty-three bulletins have been published up to the present time.

Development of Nickel Industry in Ontario

An important announcement respecting the future development of the nickel industry in the Sudbury district of Northern Ontario was made recently by J. L. Agnew, president of the International Nickel Co., who said that the development of the Frood mine, situated one and a half miles from Sudbury, would commence July 1. The total expenditure called for is \$8,000,000.

The Frood nickel deposits, Mr. Agnew stated, were the largest in the world, International Nickel alone having one hundred million tons of proven ore, and this did not include the Mond nickel holdings adjacent, which are also being developed. The International Nickel program called for a greatly increased production, he said, and mining, smelting and refining facilities would be enlarged, commensurate with this expansion.

Will Experiment in Smelting Antimony Ores

The Metallurgical & Chemical Corporation, Matawan, N. J., is perfecting arrangements for a series of experiments on the smelting of antimony ores. The work will be carried out on a practical scale to determine the advisability of handling material of this character regularly. Fifty tons of antimony ores are being secured from South America and plant facilities arranged for progressive commercial operation; new tuyeres have been installed in the 36-in. blast furnace, eliminating the old rectangular bustle, and other improvements made in the unit to provide for handling a charge of 35 to 40 tons every 24 hours.

News from Washington

By Paul Wooton

WASHINGTON CORRESPONDENT OF *Chem. & Met.*

WITH the administration exerting the full weight of its influence in an effort to get definite action on Muscle Shoals, it is apparent that another major endeavor will be made at this session of Congress to dispose of those properties. Since the appointment of a joint committee of congress, empowered to negotiate with prospective bidders, there has been a great revival of interest in this important legislative problem.

While there has been no diminution in the interest in the South in having the power distributed, there has arisen a distinct demand for the centralization of a nitrogen chemical industry at Muscle Shoals. There is a disposition on the part of many of the law makers to regard with favor a subsidy for such an industry. Some point to the fate of the ship subsidy bill as indicating what may happen to any bill proposing a direct subsidy for an industry. There is this important difference, however. The farmers of the country want this subsidy and will be the beneficiaries of it. The immediate beneficiaries of a ship subsidy bill have less influence on Capitol Hill.

The thing which killed the Ford bill was the fact that the amount of the subsidy was obscure. It can be said with great definiteness that the Senate, before placing its stamp of approval on any lease, will insist that the exact amount of the subsidy be clearly understood and be clearly stated. It, now, is common knowledge that the electric power which can be generated at Muscle Shoals is worth \$2,500,000, net. Congress is going to grant leases for the use of that power with exactly the same scrutiny as is exercised in approving an appropriation of like amount.

In the discussion of Muscle Shoals the statement frequently is made that our knowledge of nitrogen fixation is so indefinite as to preclude the establishment of any large-scale production. Such statements are arousing vigorous exceptions from American chemists. They take the position that we know as much about nitrogen fixation as do the Germans. We are deficient only in experience in operating practice and that could be acquired very promptly were the United States willing to put an embargo on imports of nitrogen, as Germany has done. A new plant employing the Haber process could be operated just as successfully in this country as in Germany, it is declared, but it is a very different matter to attempt to produce nitrogen profitably by remodeling Plant No. 2 at Muscle Shoals.

On April 10 seven bids were disclosed for leasing the entire Muscle Shoals project and two for leasing plant No. 1. One of the seven bids was that of the Muscle Shoals Power Distributing Company made on behalf of thirteen Southern power companies. The others

were made by the Union Carbide Company, New York; H. D. Walbridge Co., New York; Elon H. Hooker and associates, New York; Lloyd H. Smith, Battle Creek, Mich.; F. E. Castleberry, Shreveport, La., and the American Nitrates Company. The last was guaranteed by the American Cyanamid Company. Offers on plant No. 1 were made by James H. Levering, Washington, D. C., and American Nitrogen Products Company, Seattle.

It is understood that the committee is requiring bidders to submit propositions for on the basis of an ultimate production of 40,000 tons of nitrogen, with the understanding that the lease is to include the power properties and rights at Cove Creek. In addition the government is to build Dam No. 3.

Vegetable Oil Hearing

Confronted with requests for inclusion of the agricultural costs of producing the raw materials when it was on the eve of issuing its preliminary statement of information in its vegetable oils investigation, and of setting a date for a public hearing, the Tariff Commission granted a hearing on the requests April 3, and gave until April 24 for presentation of briefs, thus necessitating further delay in the case.

Nine governors of southern States joined in a petition to the Commission for inclusion of agricultural costs, on the ground that the interests of cotton growers would be affected adversely without such costs being considered. In behalf of L. B. Jackson, director of markets of Georgia, Senator Walter F. George of that State asked the public hearing on the question, which the Commission granted.

In testifying before the special Senate committee investigating the Tariff Commission, Vice-Chairman A. P. Dennis, of that body, cited the vegetable oil case, which includes cottonseed oil, peanut oil, soya-bean oil, and coconut oil, as an example of what he characterized as unnecessary delay on the part of the majority members of the commission in handling flexible tariff cases, but he made no reference to the April 3 hearing, or the petitions which brought it about.

Appearing before the commission April 3, Senator George confined his argument to legal questions, declaring that no report affecting any agricultural product should be made unless farm costs had been secured. Charles W. Holman, representing the National Board of Farm Organizations, and A. M. Loomis, representing the American Dairy Federation, insisted that the farmers could not be protected unless agricultural costs of the raw materials were considered, instead of merely the prices paid by crushers for their materials. The inclusion was opposed by John B. Gordon, Washington representative of the Bureau of Raw Materials, the applicant for reduction in duties,

who asserted the petition was merely a move for further delay and that the question had been considered by the Commission when the investigation was undertaken, and decided adversely to going into agricultural costs.

Demonstration of War Chemicals

A demonstration of the use of war chemicals has been arranged for May 1 at Edgewood Arsenal. On that date the Chemical Warfare Advisory Committee will inspect the arsenal and familiarize itself with the recent work at the laboratories. The members of the advisory committee are: Dr. H. E. Howe, chairman; Dr. W. D. Bancroft; Dr. W. K. Lewis; Dr. C. L. Reese; Dr. L. C. Jones; Dr. Bradley Dewey; Dr. L. T. Sutherland; Dr. Julius Stieglitz; Dr. A. S. Lovenhart; Dr. Reid Hunt; Dr. E. P. Kohler; Dr. W. H. Walker; Dr. F. M. Dorsey; Dr. A. B. Lamb, and Dr. G. A. Richter.

Because of the increasing use of poisons on farms and elsewhere the Senate Committee on Post Offices and Post Roads has approved an amendment to the postal laws which will open the mails to disinfectants, fungicides, germicides and insecticides when in special containers.

The Soil Improvement Committee of the National Fertilizer Association will meet in Atlanta, April 23.

Professor J. H. Mathews, head of the Department of Chemistry, of the University of Wisconsin, assisted by Professor G. L. Larson, of the Engineering Department, and Mr. Peabody, the state architect, have been making a study of recent chemical buildings in the eastern part of the United States preliminary to the completion of plans for the \$390,000 addition to the chemistry building of the University of Wisconsin. The visits have included Washington, Baltimore, New York City, Ithaca, and other points where buildings of this character have recently been erected.

Dr. Harry A. Curtis has been reappointed as a consultant of the Department of Agriculture with reference to its nitrogen and fertilizer work. He will cooperate with the Director of scientific work in coordinating the studies which the Department is making in this connection.

All caustic or corrosive acids and alkalis in household packages will have to bear poison labels if Congress passes a bill approved April 1 by the House Committee on Interstate and Foreign Commerce. The hearings before the committee developed the fact that the American Medical Association, the American Child Health Association and other organizations are behind the legislation. The measure has the approval of the lye manufacturers. One of the inequities of the present situation is that some manufacturers use a poison label, while others do not. The warning label militates against the sale of products so marked and penalizes the conscientious manufacturer. The proposed legislation would remove that injustice, it is contended, and would go far to reduce the heavy toll of child life being taken as a result of ignorance as to the dangerous character of caustic substances largely used in the household.

French Rayon Industry Enters Period of Rapid Expansion

Capital Appears to Be Plentiful Both for the Extension of Established Plants and for Promotion of New Projects

From Our Paris Correspondent

THE Tubize Artificial Silk Co. has created a French branch which, as was mentioned previously, has built a plant for making cellulose acetate rayon at Venissieux, near Lyons. The first financial report shows a loss of 575,000 francs on a capital of 65 million francs, which is not unusual for the initial 9 months of operation. The product is known as "Setilose."

The Silk Works of Strasbourg have increased their capital from 15 to 20 million and will eventually carry it to 40 million. This society has an agreement with the Calais Artificial Silk, which is a branch of Courtauld's Ltd. and negotiations may be under way with the Glanzstofffabriken of Elberfeld.

The society La Soie de Compiègne also has raised its capital from 15 to 25 million francs, and although it has already existed a few years, it has not yet made rayon. On the other hand, the Soie de Valenciennes, which has connections with the Hollandsche Kunstzijde Industrie of Breda, and the capital of which is about 25 million, already turns out, in its Valenciennes plant, more than 1,000 kg. of artificial silk a day.

New Plants Proposed

The Société des Textiles synthétiques will operate its plant of Terre-Neuve (New-Foundland) at Prémilhat (State of Allier) at the beginning of next year. The society La Soie de Paris plans to build a plant for rayon in the Valenciennes region in order to take advantage of Belgian labor. At the present, however, owing to the depreciation of the franc, this class of labor tends to become much scarcer in the North of France. Before the War, about 40 per cent of the industrial labor of this region was Belgian. This offered no inconvenience as the currency of both countries was at par. Now, however, the Belgians are unable to earn enough in French money to live at home and French industry can no longer retain their services because of the high wages that would be demanded.

The Borvisik Française has erected at Nevers, a plant for viscose rayon and this went into operation on December 30, 1925. It turns out 400 kg. per day and a future production of 1,500 kg. per day is planned. Its actual capital is 13 million francs, to be increased shortly to 20 million. The plant is said to be remarkable technically.

Of particular interest is the liquidation of the Fabrique de Soie artificielle of Rennes, which was organized by Count Chardonnet not long before his death and which was the only French plant using the nitrocellulose process. It is said that the shareholders will lose heavily.

At Roanne, the Cuprotextile, has erected a plant, which, as its name implies, proposes to use the cuproammonium process. In spite of its high

cost, this process is justified because finer threads may be spun than by the viscose process. The Bemberg society has lately taken out two patents on this subject (French patent Nos. 576,312 and 585,587).

La Cellulose du Pin with a capital of 20 million francs, has acquired a site between Arcachon and Fature (State of Gironde), with the view of constructing plants for the making of rayon and paper-paste.

Butyric Acid Process

For some time the society the Ketol the capital of which is 3,850,000 francs, has planned to increase this to 33,850,000 francs. It was formed to exploit the inventions of the engineer Lefranc. Production is already under way in the Ris-Orangis plant near Paris. This society is supposed to make butyric acid, using sawdust as a starting point. Sawdust is saccharified by the action of sulphuric acid utilizing, for example, a recently patented process (French patent No. 599,829) which consists in taking acid amounting to 10 per cent of the weight of the sawdust wetted with three times its weight in water and drying firstly at 100 to 130 deg. C., then at 60 to 70 deg. C., until complete dextrinification occurs. Then the residue is extracted with water and the dextrines saccharified.

After neutralization of the mineral acid and of the organic acids formed by the hydrolysis of the cellulose, the reducing sugars thus obtained at the rate of 25 kg. per 100 kg. of sawdust, are submitted to fermentation after adding from 5 to 7 per cent of calcium carbonate. This is done in closed vessel and by symbiosis fermentation: that is to say, not utilizing the pure *bacillus butyricus* but using it mixed with appropriate bacteria. At 40 deg. C., the fermentation is very active. Carbon dioxide and hydrogen are evolved, which products may be gathered as byproducts. The fermentation thus gives a mixture of fatty acids in which butyric acid prevails.

A recent improvement consists in using as an addition to the fermentation, the chalky muds coming from the defecation of the sugar juices of sugar plants which thus supply the necessary calcium carbonate and which contains, moreover, the nitrogen, phosphorus, and potash necessary to the life of the bacteria.

It is said that the society has perfected the process to obtain 15 kg. of butyric acid for each 100 kg. of sawdust; assuming a yield of 30 per cent of reducing sugar, that appears somewhat high. The price of sawdust is 25 francs per ton; butyric acid, on the other hand (the French production of which is very low: 1.5 ton per day) is worth from 30 to 35 francs per kg.

Butyric acid is used by tanners in the liming of skins; it gives also to the fine leathers the desired suppleness

especially for kid and glove-leathers. Another use for this acid which has thus become easily accessible, is the preparation of cellulose butyrate in the place of acetate; and it appears that this butyric ester produces an artificial silk more resistant to washing than is acetate silk. This product will also be used in making photographic films.

If, instead of liberating the butyric acid and the fat acids of their calcium salts by the action of sulphuric acid as explained above, we distil them on the dry state we obtain, according to well-known reactions, with separation of calcium carbonate, a mixture of ketones.

This product, comprising a mixture of many ketones in which propylketone very likely dominates, has solvent properties which are apparently superior to that of turpentine spirit or white spirit, and should find uses in varnish, smokeless powder, celluloid and linoleum.

The oil shale industry was active in France before the War in two regions: in the Autunois by the Société Lyonnaise des Schistes bitumineux d'Autun which treated annually 150,000 tons of shale, and in the Allier (bassin d'Aumance, where about 60,000 tons were distilled.

The plants of the Allier were shut down during the War and have fallen to ruins. The society of Autun was compelled to limit its production, and distills but 50,000 tons per year, so that the production has fallen to 45,000 hectolitres of crude oil, as compared with a total of 200,000 hectolitres before the War.

Oil Shale Reserves

The reserves of oil shale in the Allier, Aumance, Basses-Alpes, Var Ardèche, Vendée States, and so on, are estimated at about 50 million tons. On account of high production costs, the French industry cannot compete with the products derived from petroleum, unless it be subsidized by the Government. The method of distillation is that of the Scotch retort, the construction of which is expensive and yields but from 3 to 3.5 tons per 24 hours, and 200 kg. of coal is required per ton of shale.

It is probable that technical improvements will be realized but one cannot be too optimistic. The first thing to do would be to organize systematic researches with a view of reducing the cost of distillation and increasing the yield. With these improvements, the industry could, with the help of the State, resume on a more favorable basis. From a national standpoint, the industry deserves to be maintained and developed.

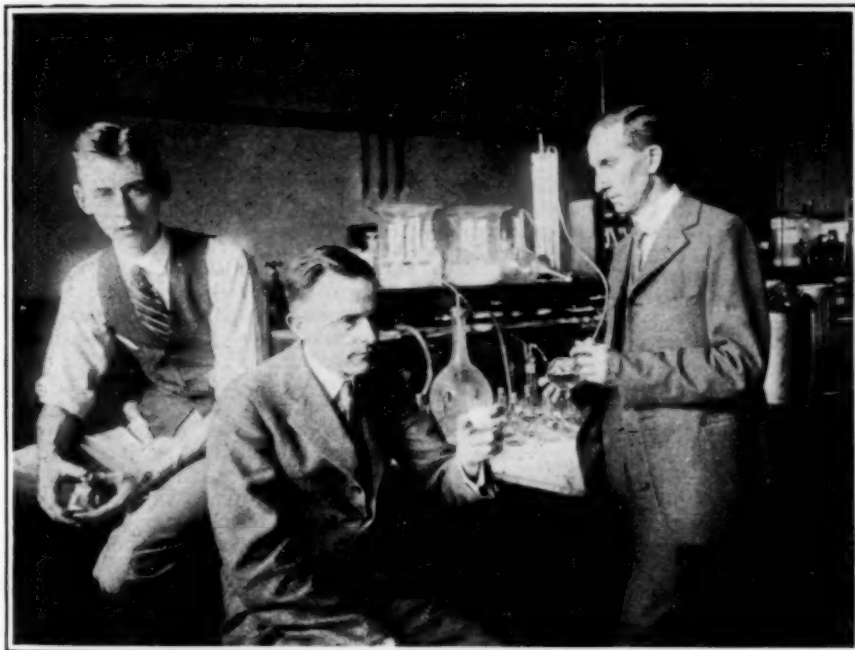
Sales of pure potash from the Alsatian mines amounted in 1925 to 310,000 tons against 270,000 tons in 1924, 253,000 tons in 1923, 228,000 tons in 1922, 110,000 tons in 1921, 199,000 tons in 1920 and 92,000 tons in 1919. Before the War, annual sales were only about 50,000 tons. The pre-war consumption in France, which was about 40,000 tons of pure potash, has now reached 120,000 tons. An agreement has been established for one year between the German Kali-Syndikat and the Alsatian concern. The contract ends April 30, 1926 but negotiations for an eventual renewing have not yet been taken up.

Mapping of Arc Spectra of Rare Earths Brings Discovery of Element No. 61

Finding of the New Element Based Upon Evidence Supplied By Arc Spectra, Absorption Spectra, and X-Ray Spectra

SEVERAL years ago a co-operative arrangement between the rare earth laboratories of the University of Illinois and the Bureau of Standards was entered into whereby the mapping of the arc spectra of the pure rare earths was to be undertaken. In examining pure neodymium and samarium materials that had been submitted to the bureau, Dr. Kiess found 130 lines common to the spectra of both of these

in 1923 by J. A. Harris and it was decided to concentrate materials using a combination of fractional crystallization of double magnesium nitrates and of the bromates. In this way it was hoped to obtain a separation of element No. 61 from the more plentiful neodymium. A new line in the absorption spectrum of the intermediate fraction was noticed when fractionation had been continued, on the bromates and



The men in the picture are; right to left: Dr. B. S. Hopkins, who was in charge of the work, L. F. Yntema, and J. A. Harris, his chief assistants. Mr. Harris holds in his hand a bottle containing a compound of which a small percentage is the newly discovered element

elements, but which checked with none of any known element.

Acting on the suggestion that these lines might be due to the presence of element No. 61, work under the direction of Professor B. S. Hopkins was commenced in an effort to isolate this element. The investigation was started by Dr. Leonard F. Yntema who later examined the materials prepared by the fractional crystallization of the double magnesium nitrates, using X-ray methods in the Sloane Laboratory of Yale University. While this examination was in progress new material was constantly supplied to him by Professor Hopkins. This examination yielded no direct evidence of the presence of the new element. In examining the arc spectrum, however, it was found that an additional 5 new lines were obtained in the ultra violet region, these being very faint in the pure neodymium and samarium but slightly more intense in intermediate fractions.

As a result of his work, Yntema concluded that if element No. 61 were present in the material it must be in amounts of less than one part per thousand. The problem was taken up

by using this band as a guide, fractions were obtained showing heavy absorption bands that could only be due to a new element. These fractions have been subjected to X-ray examination and the theoretical lines for No. 61 have been obtained. The discovery of the new element is based then upon evidence supplied by arc spectra, absorption spectra, and X-ray spectra. The name proposed for the element is illinium with symbol, Il.

International Paper Company Expanding in Canada

The enormous development being carried on by the International Paper Co. in the vicinity of Ottawa, Canada, is attracting no little attention. Full details of the company's plans were recently outlined to a gathering in Ottawa by James H. Brace, of the Fraser Brace Engineering Co., Montreal, who are doing the work. Mr. Brace stated that the initial development decided on was a 500-ton a day paper mill, with provision for possibly doubling this output of paper later; that at Chelsea on the Gatineau River, about 9 miles

north of Ottawa the company will develop power to the extent of 73,400 hp., and another 51,700 hp. at Farmers Rapids, about 5 miles from Ottawa on the Gatineau River.

Much of the ground work has already been done, both in connection with the paper mill and the power sites. Mr. Brace indicated that probably 6,000 men will be employed during the coming summer. He also stated that present indications are that the company will be ready to produce paper from its new mills on January 1, 1927.

The present installation consists of four paper machines, each with a capacity of 125 tons a day. The width of the paper passing over the roll is to be 256 inches, and the machines are to be capable of operating at over 1,000 feet per minute. Ground wood and sulphite pulp plants are to be built with sufficient capacity to furnish the paper machines with all the pulp required. In brief, the mill is to be of the most modern type, completely equipped to take the wood as it floats down the river and turn it into finished paper.

New Process for Vulcanizing Soft Rubber to Metal

As a result of a series of experiments carried out for some months past at the research laboratories of the B. F. Goodrich Co., Akron, Ohio, a new process has been developed for vulcanizing soft rubber to metal; by this process, which has been named "vulcalock," it is said that rubber will adhere securely to metal under a pressure of more than 700 lb. per sq.in. Heretofore, it has been necessary to insert a hard rubber base between soft rubber and metal to obtain proper adherence, as in the case of a solid rubber automobile tire on a metal rim. Another important feature of the process is that it will make rubber adhesive to an aluminum surface, allowing, for instance, a thin strip of rubber to be used as a covering on airplane propellers to protect them from dirt and corrosion. Rubber treated by the new process will be used by the company in its mechanical goods manufacturing division; also, it will be employed for making water-tight coverings for pontoons and for chutes in mills and factories where there is heavy abrasive action on the surface to be protected.

Decline in Receipts of Sicilian Citrate of Lime

This season's receipts of citrate of lime by the Camera Agrumaria, Messina, up to January 31, were 1,200 metric tons, compared with 1,800 tons during the parallel period of 1925. The Camera was established in 1908 by government legislation for the purpose of protecting and advancing the production and commerce of Sicilian citrus fruits and derivatives. Stocks in the Camera warehouses have been reduced from 19,000 metric tons to 15,000 tons during the last three years, consumption in recent years having exceeded production. The selling price was recently increased from 525 to 575 lire per 100 kilos.

News in Brief

New Oil Refinery for Canada—The Regal Oil Refinery Co., Canada, has completed plans for the erection of two units of an oil refinery in Tillsonburg, Ontario. Another two units are to be erected within a year, the entire program involving an expenditure of more than \$1,000,000.

Special Tank Car for Army Air Service—The Bethlehem Steel Company has developed a special helium tank-car for the Army Air Service capable of carrying 206,000 cubic feet, at 2,000 lb. pressure, or enough to inflate a medium sized blimp. Before the development of this tank car, helium gas was carried in small cylinders, 1,200 of which were necessary to inflate an airship of 210,000 cubic feet capacity.

Decline in Domestic Production of Quicksilver—Production of quicksilver in the United States in 1925 amounted to 9,174 flasks of 75 lb. each, preliminary figures compiled by the Bureau of Mines shows. The figures compare with 10,085 flasks in 1924. The 1925 production was made up by seven mines in California and six in Texas, Nevada, Arizona and Idaho. Oregon, as well as the states named, produced in 1924.

Oil and Gas Power National Conference—In keeping with the action of Secretary of Commerce Hoover in encouraging industry to stimulate research, a large group of technical societies will participate in the Oil and Gas Power National Conference with a nation-wide program of meetings during the week of April 19-24. The purpose of the Conference is to focus the attention of physicists, chemists, engineers, operating men and industries on the recent progress and immediate possibilities in the utilization of oil and gas for power purposes. The program includes over seventy-five gatherings at industrial centers where the scientific, production and economic problems related to internal combustion engines and their fuels will be discussed.

Photometric Method for Measuring Hiding Power of Paint—The Bureau of Standards has developed a photometric method for measuring the hiding power of paint. The method is very simple. The contrast is measured between the two shades of a black and white plate showing through a thin overlying coating of the paint being tested. The degree of contrast is a function of the film thickness and the hiding power of the paint. The relationship between the thickness of the paint film and the contrast which it produces has been worked out, so that by using certain formulas the hiding power in square feet per gallon can be readily calculated.

Minton Describes Special Refractories—At the March 19 meeting of the New York Section, Society of Chemical Industry (London), R. H. Minton spoke on "Some Special Refractory Prob-

lems." Mr. Minton discussed certain specifications that have been met in the manufacture of electric-furnace refractories, electric heater stove plates, chemical stoneware, saggers and metallurgical furnaces.

American Refractories Institute Will Meet—The Annual Meeting of the American Refractories Institute will be held in Philadelphia, Pennsylvania, on May 12th, at the Bellevue-Stratford Hotel. Plans are under way to have a number of papers presented by technical and practical men of the industry, and floor discussions of these papers will be invited.

Larger Potash Exports From France—The total value of Alsatian potash exports rose from 85 million francs in 1923 to 139 million in 1924 and 149 million in 1925. Exports during 1925 aggregated 737,588 metric tons of crude and refined salts, destined as follows: Belgium and Luxemburg, 491,933 metric tons; Netherlands, 85,678; United States, 56,042; Great Britain, 42,962; Italy, 20,086; Switzerland, 10,956; other countries 29,931. The potash shipped to different countries varies in the content of actual potash. While many European consumers of Alsatian potash minerals purchase salts containing low percentages of potash, shipments to the United States are largely of muriate, containing 50 to 60 per cent K_2O .

Restrictions in Use of Lead Pigments in Spain

A royal decree published February 19, provides that from the first of November, 1928, the ordinary use of white lead, sulphate of lead, or pigments containing these materials, shall be prohibited in interior painting in Spain. Excepted from the application of this decree are such jobs as are authorized by the Ministry of Labor, including their uses in painting railway stations and industrial establishments. However, white pigments containing two per cent of lead may be used. From the date of publication of this decree, however, all paint preparations containing white lead, sulphate of lead, or based upon this metal, must be properly labeled and contain the instructions "Containing Poison."

Production of Coal-Tar Products Gains in Mexico

In a recent report Consul Drew Linard, Piedras Negras, Mexico, reports the erection during 1924 of a byproducts plant at Rosita, Coahuila, introduced the manufacture of coal-tar products in that section in connection with coal and coke operations. Because of the apparent demand which has existed for the product of this plant, it is understood the other coal operators in the Sabinas coal basin are considering installations for the manufacture of coal-tar products. During 1925, the first year of local production, the total quantity of byproducts expected was valued at about \$241,000, as follows: Benzol, \$83,000; coal-tar oil, \$29,000; creosote oil, \$57,000; ammonium sulphate, \$72,000.

Rhodesia Is Largest Supplier of Chrome Ore

Shipments of domestic chromite, all containing 45 per cent or more chromic oxide, in 1925, totalled 108 long tons, valued at \$2,105, according to figures compiled by the Bureau of Mines. These shipments came from two mines in California and one mine in Maryland. The production in 1925 was 157 long tons. Two mines in California, one in Maryland, one in Oregon, and one in Washington produced this tonnage. In 1924 there were 233 long tons of chromite produced and 288 long tons, valued at \$1,140, shipped. Of the 288 tons shipped in 1924, 100 tons were from material mined in previous years, which contained less than 35 per cent chromic oxide.

The total imports of chrome ore, containing 45 per cent or more chromic oxide, for 1925 were 149,739 long tons, valued at \$1,207,420. In 1924 the total imports amounted to 118,343 long tons. In 1925 United States imports, therefore, increased 31,396 tons. The increased output of steel during 1925 accounts only in part for the increase in imports of chrome ore. The ratio, chrome used per ton of steel produced, has also increased as chrome is being used more and more in the fabrication of special grades of steel for automobile manufacture. Furthermore, the material increase in the demand for higher grade refractories in the open hearth furnaces as well as in low temperature furnaces contributed to increased importation. The chemical uses have remained relatively constant.

More than seven-tenths of the world's production now comes from Rhodesia. The mines are highly developed and are probably more extensive and more important commercially than any others now known. The cheapness with which the ore is mined and transported has made production from other world sources unremunerative. Relatively little New Caledonian ore is now produced. The Greek mines are still being operated by American interests. The Brusa mines of Anatolia have not produced since 1918. This does not mean that the ore has been exhausted, but that the mines of this locality would find difficulty in competing with Rhodesia, at best, and political conditions in Anatolia are not now favorable for mining. The production of India and Baluchistan has remained constant. The shipments from Cuba show an increase of slightly more than 200 per cent. The ore carried 42.6 per cent chromic oxide.

Paint Men Oppose Printing Formula on Container

Members of the Association of Paint Manufacturers of the United States appeared before the Senate Manufactures Committee, April 2, in opposition to proposed legislation which if enacted into law would require all manufacturers of paint to place the formula on the container. John Dewar, chairman of the legislative committee of the International Association of Master Painters and Decorators, appeared for the bill.

Men You Should Know About

H. C. PARMELEE, editor of *Chem. & Met.*, spoke before the American Oil Burner Association, in Detroit, April 7, on "The Place of Oil Burning in Industry."

DONALD M. LIDDELL has been re-elected president of The Crown Cork & Seal Co. of Baltimore City; of Crown Cork & Seal Co., Ltd., Toronto; Crown Cork & Seal Co., S. A., Mexico; American-Portuguese Cork Co., Lisbon, Port.; and Corchera Internacional of Seville, Spain. Mr. Liddell plans to be away from New York most of the time.

Dr. ING. RICHARD AMBERG, of the firm of Dr. Alb. Lessing of Nürnberg, Germany, is in this country for a few weeks on a business trip. He was formerly metallurgist for the Crucible Steel Co. of America, but is now engaged in the manufacture of carbon products in Germany.

DONALD GRENFELL is now with the Chemical and Pigments Co. (of Baltimore), as manager of the Oakland, Calif., plant, which property was taken over in the late fall from the S. F. Board of Trade. It was formerly held by Lewis, Gilman & Moore as the Metals and Chemical Extraction Corp. At the Oakland plant lithopone and other pigments and barium products will be made.

ALFRED DEEG, director of the Heyden Chemical Works, with plants in Germany and Switzerland, with headquarters at Zurich, Switzerland, recently arrived at San Francisco, Calif., from the Orient, and will be in the United States for several weeks.

EDWARD BAUSCH has been elected president of the Bausch & Lomb Optical Co., Rochester, N. Y., succeeding his father, the late John Jacob Bausch.

E. J. CASSELMAN of the Mellon Institute, Pittsburgh, Pa., has been elected chairman of the Pittsburgh section of the American Ceramic Society.

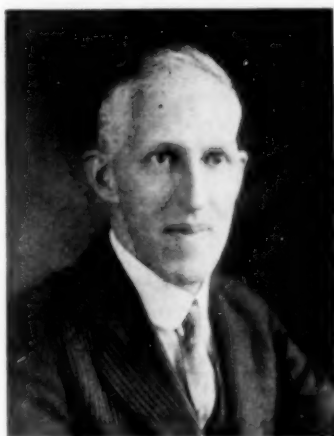
Capt. RALPH EARLE, president of the Worcester Polytechnic Institute, Worcester, Mass., has received the Distinguished Service Medal from the Government for his work as chief of the Bureau of Ordnance, United States Navy, during the war.

R. T. HASLAM, professor of chemical engineering, Massachusetts Institute of Technology, Cambridge, Mass., has been appointed director of the post-graduate course in gas and fuel engineering to be conducted at the Institute.

ROBERT CALVERT, formerly professor of industrial chemistry, University of Maryland, Baltimore, has accepted a position as chief chemist for the Van Schaack Chemical Works, Chicago, Ill.

Dr. WARREN E. EMLEY, former chief of the division of clay and silica products, Bureau of Standards, has been appointed head of a new division of the bureau, to be known as the Division of Organic and Fibre Commodities, covering research in rubber, textiles, leather and paper.

Dr. WILLIAM BLUM, of the national Bureau of Standards, has been selected as the first recipient of the American Institute of Chemists' medal. This



William Blum © Harris Bros.

medal will be awarded at the annual meeting of the Institute in New York City, at which time Dr. Blum will deliver an address on his work.

E. C. LUFKIN, chairman of the board of directors of The Texas Co., New York, has resigned because of ill health. He has been connected with the company since 1909, and will continue as a director of the organization. He was elected president of the company in 1913, and became chairman in 1920. Mr. Lufkin will be succeeded by Amos L. Beaty, president of the company since 1920.

ALFRED J. WAKEMAN, research chemist of the Connecticut Agricultural Experiment Station, has been elected a member of the scholarship scientific society at Yale University. L. R. Cerecedo, research fellow in physiological chemistry at the university, has also been elected a member of the society. Both elections are in recognition of distinguished research work.

H. L. KAUFFMAN has left the Producers and Refiners Corp. at Parco, Wyo., and set up an office as consulting engineer and petroleum and grease technologist, in Denver.

Dr. RALPH E. HALL, formerly physical chemist, U. S. Bureau of Mines, announces the foundation of Hall Laboratories, Inc., consultants on the application of recent discoveries to the elimination of scale and corrosion in steam plants.

THORNE L. WHEELER of Arthur D. Little, Inc., has been appointed by General Amos A. Fries as one of the consultants for the Chemical Warfare Service. Mr. Wheeler is a specialist in the activation of carbons which are used for gas masks.

EDWARD DEAN ADAMS, engineer, financier and scientist, received the John Fritz Gold Medal, March 30, at a public ceremony in the Engineering Auditorium, New York.

WILLIAM L. NEWTON, who has been research chemist on the staff of the Fixed Nitrogen Research Laboratory, for the past seven years, has resigned to become sales manager for the Coleman and Bell Company, manufacturing chemists, Norwood, Ohio.

A. D. CAMPBELL of the New York staff of the Oliver Continuous Filter Co. is being transferred to San Francisco.

C. W. MOORE, formerly of the Oliver Continuous Filter Co., has resigned from the Columbia Chemical Co. to rejoin the Oliver Co. in New York.

LAMMOT DUPONT has been elected president of E. I. duPont de Nemours and Co., Wilmington, Del., to succeed Irene duPont, who has declined reelection after acting in this capacity for the past 7 years. Lammot duPont is the eighth member of the family to head the company. He is 46 years of age, the son of Lammot duPont, Sr., the first to establish the dynamite industry on a permanent commercial basis in the United States. Mr. duPont was graduated from the Massachusetts Institute of Technology in 1902.

GEORGE R. BRANDES, for the past 6 years a member of the faculty at Cornell University, has become assistant professor in chemistry at Muhlenberg College, Allentown, Pa.

H. J. BLUHM, who has been chief chemist for the Brunswick-Balke-Clender Co. for a number of years, has taken the position of factory manager for the Kyloid Co., manufacturers of casein plastic materials, in Muskegon, Mich.

G. L. BATEMAN of The Dorr Co. left recently for England and expects to spend about ten days in London before sailing from Southampton to Cape Town, en route to his home in Johannesburg.

Dr. F. O. ANDEREGG has resigned as associate professor of physical chemistry in Purdue University, to accept the incumbency of the industrial fellowship on Portland cement at Mellon Institute of Industrial Research, University of Pittsburgh. Dr. Anderegg assumed his new duties on March 15.

STANLEY HUGHES, formerly with the National Aniline & Chemical Co., has joined the staff of Zaremba Co., Buffalo, N. Y., as chemical engineer.

A. M. EDMUNDS is now combustion and efficiency engineer for the United Alloy Steel Corp. of Canton, Ohio.

Market Conditions and Price Trends

Gain in Output of Mixed Paints and Varnishes Last Year

Production of Pyroxylin Lacquers More Than Tripled in the Twelve-Month Period—Declines Reported for Paste Paints

THE most important development in the paint industry in the past year, was the marked growth in production and consumption of pyroxylin varnishes or lacquers. The semi-annual canvass, made by the Department of Commerce, places production for the second half of 1925 at 6,223,200 gal. This gives a total of 11,103,400 gal. as compared with 3,591,000 gal. for 1924. In other words the 1925 production was more than three times that of 1924. Prior to 1924, production of pyroxylin lacquers was so small that it was not regarded of sufficient importance to be given a separate listing in paint and varnish classifications.

In addition to the larger output, reports from manufacturers reveal that production in the second half of 1925 proceeded at a rate more than 27 per cent in excess of activities in the first half of the same year. This indicates that production is steadily increasing and foretells an outturn in 1926 which will surpass the total for 1925. Another feature of importance is found in the fact that the number of establishments making pyroxylin lacquers, had increased from 67 in the first half of 1925 to 85 in the latter part of the year. In the latter part of 1924 there were but 45 of these manufacturing establishments.

According to data collected in the semi-annual canvass of paint and varnish manufacturers for the six-month period from July 1 to Dec. 31, 1925, there was produced 224,228,100 lb. of paste paints, comprising 138,063,300 lb. of white lead in oil, of which 132,841,700 lb. was pure and 5,221,600 lb. was not pure; 6,334,100 lb. of zinc oxide in oil; and 79,830,700 lb. of other paste paints. Production of finished products included 47,260,300 gal. of ready-mixed and semi-paste paints; 34,399,000 gal. of varnishes, japans, and lacquers other than pyroxylin.

A seasonal comparison of the last half of 1925 with the last half of 1924 brings out a decrease of 9.5 per cent for white lead in oil, with increases of 6.2 per cent and 5.9 per cent, respectively, for zinc oxide in oil and other paste paints in oil, and increases of 9.5 per cent for ready-mixed and semi-paste paints, 7 per cent for varnishes, japans, and lacquers, other than pyroxylin, and 188 per cent for pyroxylin varnishes or lacquers.

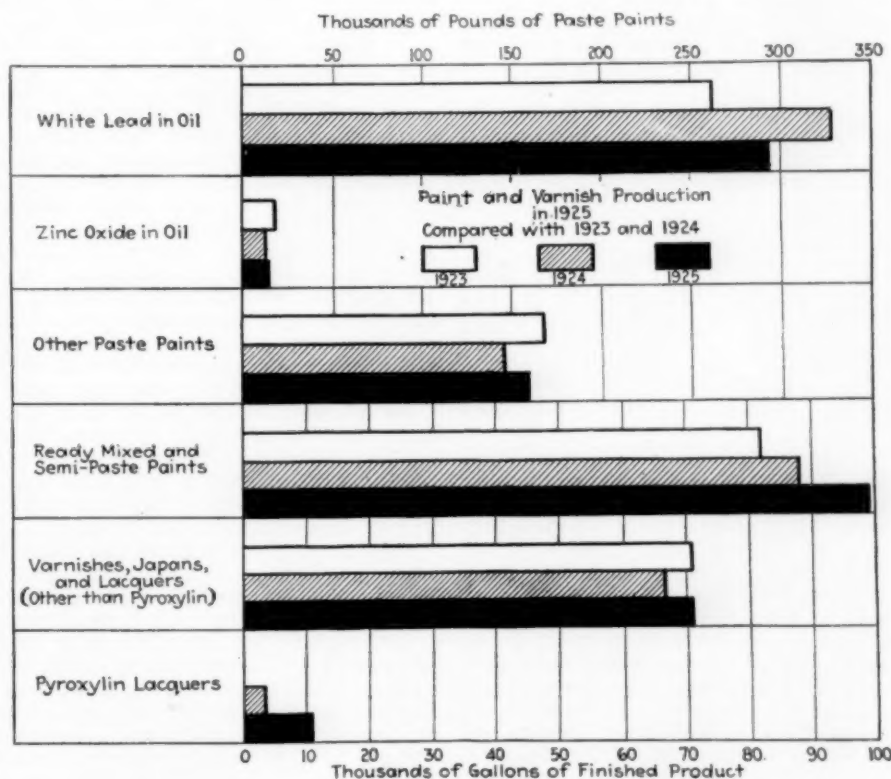
In the following table, production totals are given for the calendar year, 1925, together with comparisons for the 2 preceding years:

year show decreases of 7 per cent for paste paints, 9.9 per cent for ready-mixed and semi-paste paints, and 5.8 per cent for varnishes, japans, and lacquers, other than pyroxylin, while for pyroxylin varnishes or lacquers an increase of 27.5 per cent was registered for the period.

PRODUCTION OF PAINT AND VARNISH—1925, 1924, AND 1923

	Total Production	Total Sales	Establishments Reporting Sales			Not Classified
			Industrial	To Marine Dealers and Shipyards	To Other Jobbers and Dealers	
Paste Paints						
1925—lb.	465,285,400	363,654,100	53,880,900	5,361,400	286,677,200	17,734,600
1924—lb.	487,611,000	396,540,200	45,566,900	5,845,500	333,991,700	12,136,100
1923—lb.	439,175,000	366,575,700	46,569,200	3,184,500	289,137,700	27,684,300
White lead in oil						
1925—lb.	293,041,800	270,672,200	18,629,300	2,084,200	238,748,600	11,210,100
1924—lb.	329,811,700	310,887,700	13,649,200	1,923,300	289,687,300	5,577,900
1923—lb.	260,976,600	260,598,300	8,923,800	1,483,800	235,947,600	14,243,100
Zinc Oxide in oil						
1925—lb.	13,631,300	9,824,800	816,500	252,400	8,197,900	558,000
1924—lb.	11,921,600	9,212,700	982,600	209,500	7,727,800	292,700
1923—lb.	17,746,500	11,561,700	2,433,700	146,000	8,399,300	582,700
Other paste paints						
1925—lb.	158,612,300	83,157,100	34,435,100	3,024,800	39,730,700	5,966,500
1924—lb.	145,877,700	76,439,800	29,935,100	3,707,700	36,526,600	6,265,400
1923—lb.	160,746,500	94,422,700	35,211,700	1,554,700	44,797,800	12,858,500
Ready-mixed and semi-paste paints, including wall paints and enamels						
1925—gal.	99,709,000	74,224,700	23,256,300	2,960,200	40,960,100	7,048,100
1924—gal.	88,274,100	62,459,400	21,110,700	4,258,200	31,154,300	5,551,900
1923—gal.	82,069,700	58,595,600	22,692,100	2,833,600	28,513,600	4,556,300
Varnishes, japans, and lacquers other than pyroxylin						
1925—gal.	70,913,400	43,567,900	25,687,100	579,200	14,081,400	3,220,200
1924—gal.	66,859,400	42,657,100	23,700,400	946,300	14,496,100	3,514,300
1923—gal.	70,731,000	51,852,900	31,152,900	778,300	15,053,100	4,868,600
Pyroxylin varnishes and lacquers						
1925—gal.	11,103,400	10,029,200	8,373,400	32,900	1,038,300	584,600
1924—gal.	3,591,000	2,853,500	1,952,100	12,700	428,600	460,200

Statistics for the last half of 1925 as compared with the first half of that year show decreases of 7 per cent for paste paints, 9.9 per cent for ready-mixed and semi-paste paints, and 5.8 per cent for varnishes, japans, and lacquers, other than pyroxylin, while for pyroxylin varnishes or lacquers an increase of 27.5 per cent was registered for the period.



Market Conditions and Price Trends

Consumption of Chemicals Maintains Large Volume

Operations in Manufacturing Industries Create Demand for Larger Supplies of Raw Materials Than a Year Ago

PRODUCERS of chemicals continue to report a steady withdrawal against existing contracts and this is pointed to as proof that consumption is holding up to the high standards established in recent months. Seasonal falling off in activity is making itself felt in some manufacturing lines but this is more than offset by enlarged operations in other industries and there is evidence that total consumption of chemicals is running ahead of that for the corresponding period of last year.

Latest available reports indicate a pronounced gain in activity in the fertilizer trade as compared with the early months of 1925. Similar conditions are found in the production of automobile tires, in petroleum refining, and in the glass trade. To a lesser extent this increase in productive activity is found in the leather, paper and pulp, and chemical industries. These deductions are drawn from a comparison of employment figures covering the first 2 months of the year. The employment statistics are collated by the Bureau of Labor and are based on surveys of a large percentage of manufacturing establishments. These statistics are reduced to weighted index numbers for each group of industry. Based on the weighted index number of employment, production of chemicals in February went along at the same rate as in the preceding month and the two-month period shows a gain of about 3.5 per cent over the corresponding period of 1925.

The weighted index numbers for employment in the chemical trade and in the principal consuming trades, offer the following comparisons:

INDEX OF EMPLOYMENT

	Feb., 1926	Jan., 1926	Feb., 1925
Dyeing and finishing textiles	101.4	101.4	101.8
Leather	93.3	92.6	92.7
Paper and pulp	95.3	95.1	94.2
Chemicals	95.3	95.3	92.5
Fertilizer	122.2	107.4	98.0
Glass	97.2	95.1	91.1
Automobile tires	113.7	112.6	106.1
Petroleum refining	98.0	97.6	89.6

According to the index number of the Department of Commerce, covering 64 commodities, manufacturing in February, 1926, after adjustment for differences in working time, at 130 per cent of the 1919 average, was greater than in January, 1926, and 5 per cent higher than in February, 1925. The principal increases over January occurred in the production of lumber, with a gain of 6 per cent, and miscellaneous products, including automobiles, with a gain of 10 per cent. Decreases from January occurred in the production of foodstuffs, textiles, iron and steel, leather, paper and printing, chemicals and oils, stone, clay and glass products, non-ferrous

metals and tobacco, due principally to seasonal tendencies and to the shorter number of days in the month. Compared with a year ago, declines in foodstuffs textiles, leather, stone, clay and glass products and non-ferrous metals were more than offset by increases in lumber, iron and steel, paper and printing, chemical and oil products, tobacco and the miscellaneous groups, including automobiles.

The output of raw materials was 2 per cent less than in February, 1925, animal marketings declining 5 per cent, crop marketings 1 per cent, lumber output gaining 5 per cent and mineral production showing no change.

Stocks of commodities held at the end of February showed a decrease from January, 1926, and an increase over February, 1925, stocks of raw foodstuffs and other raw materials for manufacture and manufactured commodities being higher than a year ago, while manufactured foodstuffs were smaller.

The index of unfilled orders showed a decline from January and a year ago, both the iron and steel and building materials groups being smaller than in February, 1925.

An idea of producing and consuming activities for the next three months in the Middle Atlantic States may be gained by reference to reports submitted at the conference of Atlantic States Shippers Advisory Board held at Rochester, N. Y. on April 8. These reports state that industry will more than hold its own during the second quarter of 1926, as compared with the corresponding quarter of 1925. A survey by 25 major industries in this territory to determine freight car requirements for the next three months shows that 9 industries expect an average increase in business of 12 per cent; 13 industries expect to do the same volume of trade, and 3 industries look for a slight decrease.

A summary of the car requirements of the most important industries in the middle Atlantic States for the next three months, as compared with the same months of 1925, follows: The cement industry expects as good a year in 1926 as during 1925. The car requirements for April, May and June will be approximately 80,000 cars.

Shipments of petroleum and petroleum products for the next three months are expected to show an increase of 15 per cent over a year ago.

Cotton-piece goods will show an increase of 5 per cent; bleach goods an increase of 10 per cent; oil cloth and linoleum an increase of 50 per cent, and felts an increase of 7 per cent. No change is expected in cotton yarns, suitings, carpets, pile fabrics and rayon silk. A decrease of 10 per cent in natural silk is anticipated.

An increase of 15 per cent in shipments of machinery is anticipated. The committee stressed the fact that no difficulty had been experienced during the past quarter in securing equipment for loading.

More than two-thirds of the paper mills reporting, expect to do the same business during the next quarter that they did a year ago. The rest of the industry looks for a slight increase.

Business for the next three months will be at the same volume as a year ago for these industries: automotive parts, chemical, fertilizer, general food products, iron and steel, roofing, rubber, salt, slate and tobacco.

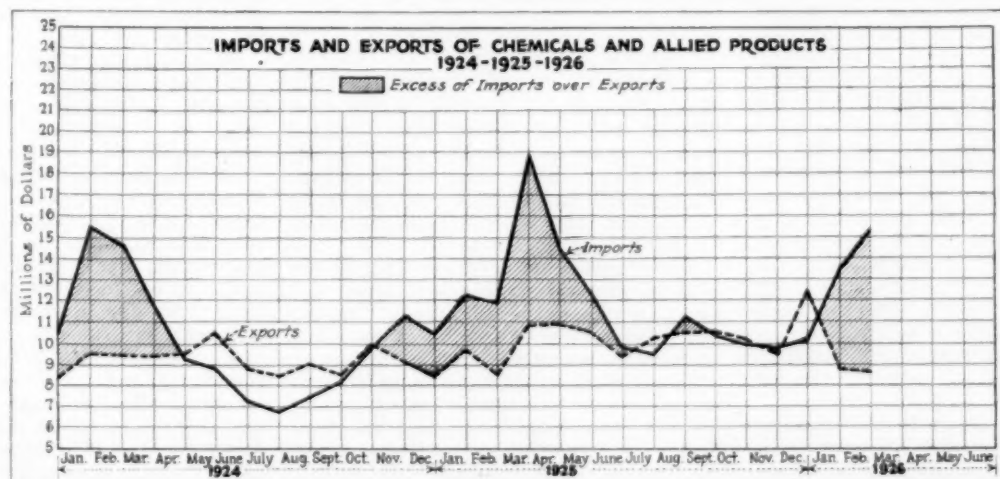
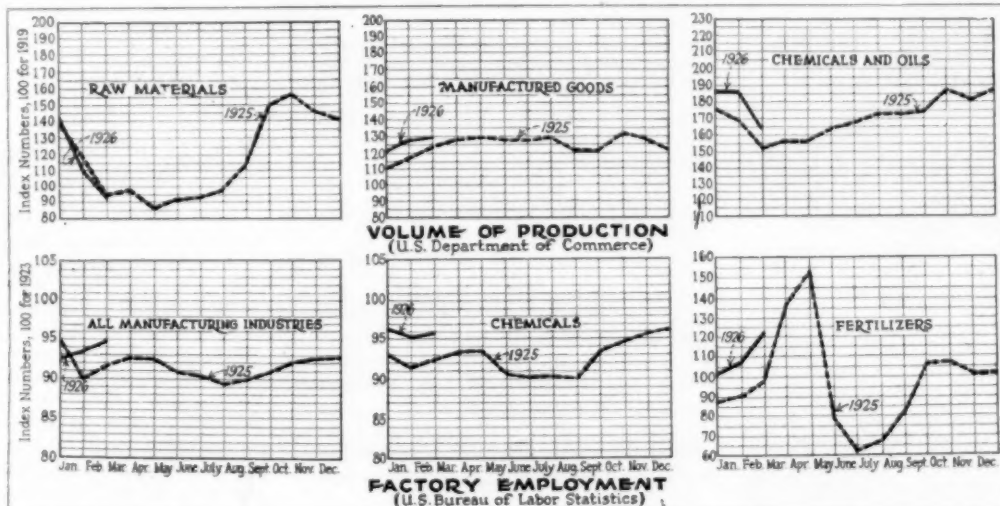
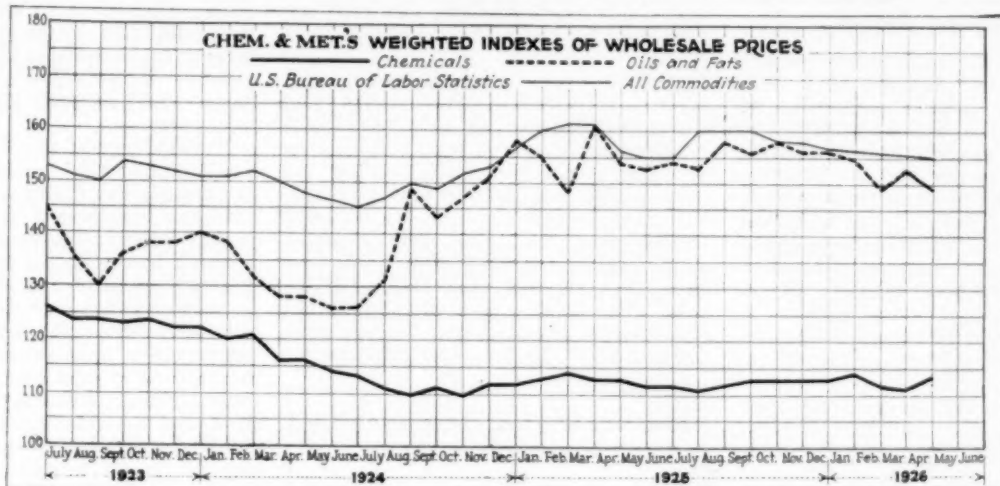
The weighted index number for chemicals moved upward during the month. Advances in values for sulphur and the stronger position of sulphuric acid were the most important factors in bringing about the rise in the index number. Price changes for important chemicals were infrequent during the month and there does not appear to be any decided trend toward higher or lower levels. The weighted number is now 113.25 as compared with 112.08 a month ago and 112.60 a year ago.

A decidedly easy tone was manifest in the markets for vegetable oils and fats. Both crude and refined cottonseed oil shared in a steadily declining price movement. Linseed oil did not fluctuate much but large supplies and only moderate buying caused a sharp drop in the market for China wood oil. Other vegetable oils showed an easy price trend and animal fats also were selling more in buyers favor. As a result the weighted index number settled at 149.09 which compares with 152.43 a month ago and 154.01 a year ago.

The aggregate value of the exports of chemicals and related products rose 5 per cent from \$11,686,000 in February, 1925 to \$12,263,000 in February, 1926, while the imports advanced 22 per cent from \$17,532,000 to \$21,325,000, according to the Bureau of Foreign and Domestic Commerce. Due to the continued strong demand for fertilizers, imports of group 8 valued at \$15,200,000 representing 70 per cent of the total were well above the imports for the preceding February. Exports valued at \$8,700,000 were also in excess of the previous February's figure but only by 5 per cent.

The largest difference in the foreign trade of the groups was made in the coal-tar products group when exports valued at \$552,000 in February, 1926 were not only 38 per cent under the February, 1925 figure but were also considerably below the monthly average while imports of \$1,709,000 were 28 per cent over February 1925 and about the average monthly import of the past two years. Foreign sales of crudes and intermediates recorded a decided falling off, whereas with the exception of dyes which class, however, formed three-quarters of the total, finished products advanced. Exports of dyes amounted to \$404,000 (1,611,000 lb.).

Chem. & Met.'s Statistics of Business In The Chemical Engineering Industries



Market Conditions and Price Trends

Heavy Demand Forces Advance In Sulphur Prices

For the last 2 years domestic production of sulphur has not been large enough to take care of consuming requirements and it has been necessary to draw upon reserve stocks to take care of buying orders. Last year domestic consumption of sulphur was the largest in the history of the trade and export shipments likewise established a record. So far this year, domestic consumption has been well up to the standard set last year and official returns show that the export movement in January and February accounted for a total of 109,518 tons as compared with 95,817 tons for the corresponding period of last year, or a gain of more than 14 per cent. The statistical position, therefore, has been working toward a further reduction of stocks in the hands of producers. Naturally this has had a strengthening effect on market values and leading producers, in the latter part of March, revised sales prices upward, making the quotation for bulk shipments, \$19 per ton at mines and the export price \$23 per ton f.a.s. New York.

The following table offers comparisons of the amount of sulphur produced in the last 3 years with figures included to show shipments from mines and the volume of stocks held by producers at the close of the years specified:

	Domestic Production of Sulphur Ton	Shipments from Mines Ton	Stocks in Producers Hands Ton
1925	1,409,240	1,857,970	2,250,000
1924	1,220,561	1,537,345	2,700,000
1923	2,036,097	1,618,841	3,000,000

The Bureau of Mines has just issued a report on production and exports of sulphur in 1925. This report says that domestic production of sulphur in 1925 amounted to 1,409,240 long tons compared with 1,220,561 tons in 1924. Shipments from mines in 1925 totaled 1,857,970 long tons compared with 1,537,345 tons in 1924, and were greater by 239,129 tons than the shipments in 1923, the previous year of greatest movement. As in 1924 shipments were considerably in excess of production. Stocks in the hands of producers were thus reduced from 2,700,000 long tons at the beginning of the year to 2,250,000 tons at the end of the year, the lowest level since the end of 1921, and 750,000 tons lower than those on hand at the end of 1923. The estimated value of the shipments in 1925 is \$29,000,000. Exports of sulphur or brimstone in 1925 were the largest ever recorded, being 629,401 long tons, compared with 482,114 tons in 1924, and were 30 per cent higher than those of 1922, the previous year of highest record.

The increase in domestic consumption of sulphur is due, in part, to increased activity in consuming trades and, in part, to the fact that, in recent years, producers of sulphuric acid have been using sulphur to replace pyrites. The increase in foreign trade has re-

sulted from improved industrial conditions in foreign markets and also has been aided by lessened competition from Sicilian producers. A report to the Department of Commerce early this month stated that sulphur exports from Sicily declined during 1925 to 255,204 metric tons, compared with 303,463 tons in 1924. The production during the same period was 207,998 tons and 223,577 tons respectively. Stocks on hand on December 31, 1925, were reported at 111,718 tons, a decline of 63,983 tons from that reported for December 31, 1924. The decline in production is not attributed to exhaustion of the deposits, but rather to the financial condition of

Leading Market Developments During the Month

Sulphur prices have been advanced as a result of large shipments which have reduced stocks at producing points.

United States Customs Court handed down decision sustaining the constitutionality of the flexible provisions of the Tariff Act.

Import statistics reveal that recent importations of linseed oil have been coming largely from German markets.

The charge has been made in Great Britain that American exporters have been dumping zinc oxide in English markets.

Reports from Southern states indicate an increase over last year of 2 per cent in consumption of fertilizers during the coming season.

the producers. The prevailing prices of sulphur, apparently do not leave a sufficient margin of profit to producers, who are faced with high production costs on account of the antiquated methods of extraction.

Boll Weevil Report Stimulates Calcium Arsenate

A warning that the South may expect a serious onslaught from the cotton boll weevil this year and that a vigorous campaign should be conducted to reduce damage to the crop was issued by the Department of Agriculture on April 3.

For the past two years, the Department states, climatic conditions have been unfavorable to the weevil and heavier crops of cotton have resulted with consequent effects upon American foreign trade and world prices. This period had come to an end, it is stated, and the weevil is returning to its work of devastation.

The Department foresees that, unless summer conditions contain some element to retard the advance of the insect, the cotton outturn next fall will be appreciably affected.

The report states that these records only indicate the initial emergence of weevils from hibernation and the final factor in determining the damage will be the summer climatic conditions. Certainly, some sections now face a very serious infestation and the vast majority of the cotton area has at least a normal crop of weevils.

In other words, the climatic conditions unfavorable to the weevil during the past two years have been very largely overcome and the farmer should prepare himself for a vigorous campaign to reduce damage to the minimum.

The findings of the Department have had a stimulating effect on the market for arsenic and calcium arsenate. This has not manifested itself in an improved trading movement but it has aroused hopes that a good call will be felt for arsenate and that demand will be large enough not only to take surplus stocks from the market but also to encourage a fair volume of new production. The last two seasons in the arsenate trade were far from profitable as weevil infestation was light and the market was laboring under the handicap of large unsold stocks both of arsenic and arsenate. If the coming season should progress along similar lines there would be enough arsenate in the country to fill consuming requirements and new production would mean another over-supply. Even under favorable conditions, producers undoubtedly will go slow in turning out supplies until they are better able to estimate the probable demand.

Charge of Dumping Zinc Oxide in English Markets

Last month a discussion arose in the British Parliament relative to importations of zinc oxide into British markets. The charge was made that foreign countries were selling this material in these markets at prices lower than were quoted in the countries of origin. The United States and Germany were named as offenders in this respect. Attention was called to the fact that export shipment of the oxide from the United States and also to low-priced quotations which had been prevalent. The discussion was of an informal nature but it was suggested that manufacturers of zinc oxide in Great Britain have a recourse inasmuch as they can petition for anti-dumping duties as provided under the Safeguarding of the Industries Act.

Reference to official statistics bears out the statement that American exports of zinc oxide have been increasing. In February export shipments were 2,542,975 lb. as compared with 1,542,085 lb. in February, last year. For the eight months ended February, exports were 17,164,234 lb. as compared with 7,034,620 lb. for the corresponding period last year. In January exports were 2,576,439 lb. and of this total, 1,366,400 lb. or more than 53 per cent was consigned to the United Kingdom. Canada took 786,312 lb. and the remainder was distributed in small amounts. The average price of January shipments to the United Kingdom was 6.17c. per lb. and to Canada, 7.40c. per lb. Owing to the range in prices for zinc oxide according to grade, these prices mean but little in the way of comparisons.

The Bureau of Mines has just issued

